ERDC/EL TR-06-3

Environmental Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

Wetlands Regulatory Assistance Program

Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region

U.S. Army Corps of Engineers

February 2006

Wetlands Regulatory
Assistance Program

ERDC/EL TR-06-3
February 2006

Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region

U.S. Army Corps of Engineers

U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Final report

Prepared for U.S. Army Corps of Engineers
Washington, DC 20314-1000

ABSTRACT: This document is one of a series of Regional Supplements to the Corps of Engineers Wetlands Delineation Manual, which provides technical guidance and procedures for identifying and delineating wetlands that may be subject to regulatory jurisdiction under Section 404 of the Clean Water Act. The development of Regional Supplements is part of a nationwide effort to address regional wetland characteristics and improve the accuracy and efficiency of wetland-delineation procedures. This supplement is applicable to the Alaska Region, which is defined herein as the entire state of Alaska.

Contents

Preface

This document is one of a series of Regional Supplements to the Corps of Engineers Wetland Delineation Manual. It was developed by the U.S. Army Engineer Research and Development Center (ERDC) at the request of Headquarters, U.S. Army Corps of Engineers (USACE), with funding provided through the Wetlands Regulatory Assistance Program (WRAP).

This document was developed in cooperation with the Alaska Regional Working Group, whose members contributed their time and expertise to the project over a period of many months. Working Group meetings were held in Anchorage, AK, on 3-5 February 2004, 16-17 November 2004, and 30 November-1 December 2005. Members of the Regional Working Group and contributors to this document were:

James Wakeley, Project Leader and Working Group Chair, Environmental Laboratory (EL), ERDC, Vicksburg, MS

Robert Lichvar, Chair, Vegetation Subcommittee, Cold Regions Research and Engineering Laboratory, ERDC, Hanover, NH

Chris Noble, Chair, Soils Subcommittee, EL, ERDC, Vicksburg, MS

Joe Moore, Co-Chair, Soils Subcommittee, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service, Palmer, AK

Harry Baij, Jr., U.S. Army Engineer Alaska District, Anchorage, AK

Mark Clark, USDA Natural Resources Conservation Service, Palmer, AK

David D'Amore, USDA Forest Service, Pacific Northwest Research Station, Juneau, AK

Jacqueline de Montigny, USDA Forest Service, Tongass National Forest, Wrangell, AK

Christy Everett, U.S. Army Engineer Alaska District, Fairbanks Field Office, Fairbanks, AK

Michiel Holley, U.S. Army Engineer Alaska District, Anchorage, AK

Patricia Krosse, USDA Forest Service, Tongass National Forest, Ketchikan, AK

Cole Mayn, USDA Forest Service, Tongass National Forest, Craig, AK

Sheila Newman, U.S. Army Engineer Alaska District, Fairbanks Field Office, Fairbanks, AK

Bill Pearson, National Wetlands Inventory, U.S. Fish and Wildlife Service, Anchorage, AK

Chien-Lu Ping, University of Alaska Fairbanks, Palmer Research Center, Palmer, AK

Mary Lee Plumb-Mentjes, U.S. Army Engineer District, Alaska, Anchorage, AK

Jim Powell, Alaska Department of Environmental Conservation, Juneau, AK

Ann Puffer, USDA Forest Service, Alaska Region, Juneau, AK

Ralph Thomas Rogers, U.S. Environmental Protection Agency (EPA), Seattle, WA

Michelle Schuman, USDA Natural Resources Conservation Service, Palmer, AK

Gerald Tande, National Wetlands Inventory, U.S. Fish and Wildlife Service, Anchorage, AK

Initial technical reviews were provided by the following members of the National Advisory Team for Wetland Delineation: Steve Eggers, U.S. Army Engineer (USAE) District, St. Paul, MN; Dan Martel, USAE District, San Francisco, CA; Jennifer McCarthy, NRCS, Washington, DC; Paul Minkin, USAE District, New England, Concord, MA; Ralph Thomas Rogers, EPA, Seattle, WA; Stuart Santos, USAE District, Jacksonville, FL; Ralph Spagnolo, EPA, Philadelphia, PA; Ralph Tiner, U.S. Fish and Wildlife Service, Hadley, MA; P. Michael Whited, NRCS, Holden, MA; and James Wood, USAE District, Albuquerque, NM. In addition, independent peer reviews were performed in accordance with Office of Management and Budget guidelines. The peer review team consisted of William W. Wood III, Chair, NRCS, Palmer, AK; Steve Becker, ASCG Inc., Fairbanks, AK; Janet Kidd, ABR Inc., Fairbanks, AK; Anne Leggett, HDR Alaska, Anchorage, AK; Cheryl Moody, Three Parameters Plus, Palmer, AK; Edmond C. Packee, Jr., Travis-Peterson Environmental Consulting Inc., Fairbanks, AK; Bill Streever, BP Exploration (Alaska) Inc., Anchorage, AK; and Joe D. White, NRCS, Anchorage, AK.

Technical editors for this Regional Supplement were Dr. James S. Wakeley, Mr. Robert W. Lichvar, and Mr. Chris V. Noble, ERDC. Ms. Katherine Trott was the project proponent and coordinator at Headquarters, USACE. During the conduct of this work, Dr. Morris Mauney was Chief of the Wetlands and Coastal Ecology Branch; Dr. David Tazik was Chief, Ecosystem Evaluation and Engineering Division; and Dr. Edwin Theriot was Director, EL.

COL James R. Rowan was Commander and Executive Director. Dr. James R. Houston was Director of ERDC.

The correct citation for this document is:

U.S. Army Corps of Engineers. (2006). "Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region," J. S. Wakeley, R. W. Lichvar, and C. V. Noble, eds. ERDC/EL TR-06-3, US Army Engineer Research and Development Center, Vicksburg, MS.

1 Introduction

Purpose and Use of This Regional Supplement

This document is one of a series of Regional Supplements to the Corps of Engineers Wetland Delineation Manual (hereafter called the Corps Manual). The Corps Manual provides technical guidance and procedures, from a national perspective, for identifying and delineating wetlands that may be subject to regulatory jurisdiction under Section 404 of the Clean Water Act (33 U.S.C. 1344). According to the Corps Manual, identification of wetlands is based on a three-factor approach involving indicators of hydrophytic vegetation, hydric soil, and wetland hydrology. Indicators are generally site-specific but should be evaluated in a broader context including landscape position, human influences, and other factors. This Regional Supplement presents wetland indicators, delineation guidance, and other information specific to the Alaska Region.

This Regional Supplement is part of a nationwide effort to address regional wetland characteristics and improve the accuracy and efficiency of wetland-delineation procedures. Regional differences in climate, geology, soils, hydrology, plant and animal communities, and other factors are important to the identification and functioning of wetlands. These differences cannot be considered adequately in a single national manual. The development of this supplement follows National Academy of Sciences recommendations to increase the regional sensitivity of wetland-delineation methods (National Research Council 1995). The intent of this supplement is to bring the Corps Manual up to date with current knowledge and practice in the region and not to change wetland boundaries. The procedures given in the Corps Manual, in combination with wetland indicators provided in this supplement, can be used to identify wetlands for a number of purposes, including resource inventories, management plans, and regulatory programs. The determination that a wetland is subject to regulatory jurisdiction under Section 404 must be made independently of procedures described in this supplement.

This Regional Supplement is designed for use with the current version of the Corps Manual (Environmental Laboratory 1987) and all subsequent versions. Where differences in the two documents occur, this Regional Supplement takes precedence over the Corps Manual for applications in the Alaska Region. Table 1 identifies specific sections of the Corps Manual that are replaced by this supplement. Other guidance and procedures given in this supplement and not listed in Table 1 are intended to augment the Corps Manual but not necessarily to

replace it. The Corps of Engineers Alaska District has final authority over the use and interpretation of the Corps Manual and this supplement in Alaska.

Table 1
Sections of the Corps Manual Replaced by this Regional Supplement for Applications in Alaska

Item	Replaced Portions of the Corps Manual (Environmental Laboratory 1987)	Replacement Guidance (this Supplement)
Hydrophytic Vegetation Indicators	Paragraph 35, all subparts, and all references to specific indicators in Part IV	Chapter 2
Hydric Soil Indicators	Paragraphs 44 and 45, all subparts, and all references to specific indicators in Part IV	Chapter 3
Wetland Hydrology Indicators	Paragraph 49(b), all subparts, and all references to specific indicators in Part IV	Chapter 4
Growing Season Definition	Glossary	Chapter 4, Growing Season; Glossary
Hydrology Standard for Highly Disturbed or Problematic Wetland Situations	Paragraph 48, including Table 5 and the accompanying User Note in the online version of the Manual	Chapter 5, Wetlands that Periodically Lack Indicators of Wetland Hydrology, Procedure item 2(e)

Indicators and procedures given in this Supplement are designed to identify wetlands as defined jointly by the Corps of Engineers (33 CFR 328.3) and Environmental Protection Agency (40 CFR 230.3). Wetlands are a subset of the “waters of the United States” that may be subject to regulation under Section 404. One key feature of the definition of wetlands is that, under normal circumstances, they support “a prevalence of vegetation typically adapted for life in saturated soil conditions.” Many waters of the United States are unvegetated and thus are excluded from the Corps/EPA definition of wetlands, although they may still be subject to Clean Water Act regulatory jurisdiction (33 CFR 328.3a). Other potential waters of the United States in Alaska include, but are not limited to, tidal waters, lakes, rivers, streams, mud flats, and similar areas. Delineation of these waters in non-tidal areas is based on the “ordinary high water mark” (33 CFR 328.3e) or other criteria, and is beyond the scope of this Regional Supplement.

Amendments to this document will be issued periodically in response to new scientific information and user comments. Between published versions, Headquarters, U.S. Army Corps of Engineers, may provide updates to this document and any other supplemental information used to make wetland determinations under Section 404. Wetland delineators should use the most recent approved versions of this document and supplemental information. The Corps of Engineers has established an interagency National Advisory Team for Wetland Delineation whose role is to review new data and make recommendations for needed changes in wetland-delineation procedures to Headquarters, U.S. Army Corps of Engineers. Items for consideration by the Team, including full documentation and supporting data, can be submitted to:

National Advisory Team for Wetland Delineation
Regulatory Branch (Attn: CECW-CO)
U.S. Army Corps of Engineers
441 G Street, N.W.
Washington, DC 20314-1000

Applicable Region

This supplement is applicable to the Alaska Region, which is defined herein as the entire state of Alaska. The whole state was identified for development of this supplement in part because of its geographic isolation from the rest of the United States and in part by its climate, which is typical of high latitudes. Alaska is characterized by a humid temperate climate along the southeastern coast and a polar climate across the rest of the state (Bailey 1998). The polar climate is controlled mainly by polar and arctic air masses. In general, temperatures are low, winters are severe, and annual precipitation is low, much of it occurring during summer. Although day length during summer can be long, the intensity of solar radiation and potential for evapotranspiration are relatively low. Soils are usually frozen during the winter and the growing season is short.

The humid temperate climate of southeastern Alaska is influenced by both polar and tropical air masses and is characterized by warmer temperatures and abundant precipitation. Summers tend to be cool and moist, and the annual temperature range is relatively narrow due to the proximity of the ocean (Bailey 1995, 1998). Wetland indicators presented in this supplement are applicable across the entire state.

Physical and Biological Characteristics of the Region

The Alaska Region encompasses a vast area that extends over 2,400 miles (3,860 km) east to west and over 1,400 miles (2,250 km) north to south. Alaska's land surface covers more than 586,000 square miles (1,517,700 km^2), most of which is located north of 60° N latitude and extends well above the Arctic Circle. Climate, geology, and landforms are highly variable across the region. Northern portions of Alaska are underlain by continuous permafrost, which becomes discontinuous, isolated, and fades away toward the south. Plant communities are also spatially variable, ranging from the grass, sedge, lichen, and dwarf-shrub communities of the arctic tundra to the coniferous rainforests of southeastern Alaska. Detailed descriptions of the various subregions of Alaska can be found in USDA Natural Resources Conservation Service (2004). A generalized map of subregions is given in Appendix B (Figure B1).

Types and Distribution of Wetlands

Wetlands are more abundant in Alaska than in any other region of the United States. According to the National Wetlands Inventory, wetlands (including shallow subtidal habitats in coastal areas) occupy more than 174 million acres (70 million ha) and comprise more than 43 percent of the state's surface area (Hall, Frayer, and Wilen 1994). Nearly 99 percent of Alaska's wetlands are classified as palustrine, of which approximately 67 percent are scrub/shrub, 25 percent are emergent, and 8 percent are forested.

Alaska's wetlands are as varied as its landscapes. They include salt marshes, bogs, muskegs, fresh marshes, swamps, and wet and moist tundra. Wetland abundance varies considerably by subregion and locale. Wetlands occupy an average of 61 percent of northern and western Alaska (approximately 93 million acres or 38 million ha of wetlands). They are least abundant in the Brooks Range (approximately 22 percent wetlands) and most abundant (up to 83 percent of the land area) in the arctic foothills and coastal plain, and in the Yukon-Kuskokwim and Selawik-Kobuk deltas. Vast expanses of treeless tundra underlain by permafrost dominate the area. More than half of all of Alaska's wetlands are located in the Northern and Western subregions.

In contrast, only about 13 percent of the land area in Southcentral, Southeast, and Aleutian Alaska consists of wetlands (9 million acres or 3.7 million ha). These subregions contain about 5 percent of Alaska's total wetland resource. Wetlands are less abundant in the mountains (<3 percent wetlands) and more abundant in the southeastern lowlands (34.5 percent wetlands) and in the Cook Inlet-Susitna lowlands (28 percent wetlands). Slope wetlands are common in the southeast due to abundant precipitation and shallow bedrock. More than one-third of the wetlands in these subregions are forested.

Approximately 44 percent of Interior Alaska is wetlands (total of 71 million acres or 29 million ha), with the greatest wetland abundances in the Kanuti flats (76.5 percent wetlands), the Koyukuk-Innoko lowlands (71.1 percent), and the Tanana-Kuskokwim lowlands (60.9 percent). Interior Alaska contains approximately 40 percent of the State's total wetland acreage, including millions of acres of black spruce (*Picea mariana*) muskeg and floodplain wetlands dominated by deciduous shrubs and emergent plants. Wetlands are common on north-facing slopes where shallow permafrost traps water near the surface. Seventy-four percent of the wetland area in the subregion is classified as scrub/shrub, 13 percent is forested, and 13 percent is emergent (Hall, Frayer, and Wilen 1994).

2 Hydrophytic Vegetation Indicators

Introduction

In wetlands, the presence of water for long periods during the growing season exerts a controlling influence on the vegetation and dictates the kinds of plants that can establish and maintain themselves. Therefore, certain characteristics of the vegetation are strong evidence for the presence of wetlands on a site. The Corps Manual uses a plant-community approach to evaluate vegetation. Hydrophytic vegetation decisions are based on the assemblage of plant species on a site, rather than the presence or absence of particular indicator species. In general, hydrophytic vegetation is present when the plant community is dominated by species that can tolerate prolonged inundation or soil saturation during the growing season.

Many factors besides site wetness affect the composition of the plant community in an area, including regional climate, local weather patterns, topography, soils, and plant distributional patterns at various spatial scales. Community composition reflects the adaptive capabilities of the plant species and individuals present, superimposed on a complex spatial pattern of hydrologic, edaphic, and other environmental conditions. Disturbance factors, such as floods, fires, drought, or recent site modifications, are also important. They can set back or alter the course of plant succession, and may even change the hydrophytic status of the community. For example, intense fires in wetlands underlain by shallow permafrost and dominated by species such as black spruce can burn both the standing vegetation and the peat layer that insulates and helps maintain the permafrost layer. Thawing of the permafrost, as a result of intense burns, can result in improved soil drainage in some settings and can shift vegetation composition from hydrophytic to non-hydrophytic in one or more growing seasons. This shift in vegetation can last 50 to 70 years in interior Alaska’s black spruce communities before the insulating moss layer develops sufficiently to reestablish both the permafrost layer and original plant community (Viereck, Van Cleve, and Dyrness 1986). Wetland determinations in such areas depend, in part, on the investigator’s assessment of the permanence of the changes in site conditions using all available information and best professional judgment.

In most cases, hydrophytic vegetation decisions are based on the wetland indicator status (Reed 1988) of plant species in the community. However, species in the facultative categories (FACW, FAC, and FACU) are recognized as occurring in both wetlands and uplands to varying degrees. Many facultative species have adaptive strategies allowing them to inhabit various landscape positions across the moisture gradient. Most wetlands are dominated by species rated OBL, FACW, and FAC. However, certain uncommon wetland types in Alaska may support primarily FACU species, such as paper birch (*Betula papyrifera*) or field horsetail (*Equisetum arvense*). These situations arise in part due to the broad tolerances of certain plant species that allow them to be widely distributed across the moisture gradient (i.e., ecological plasticity) or to the existence of ecotypes (i.e., populations of a species that are better adapted for life in wetlands than most members of the species). Hydrophytic vegetation indicators and procedures presented in this chapter are designed to identify the majority of wetland plant communities in Alaska. However, some wetland communities may lack any of these indicators. These situations are considered in Chapter 5, "Difficult Wetland Situations in Alaska."

People who make wetland determinations in Alaska should be able to identify most of the common plants that occur in the areas where they work. Lists of common species in each subregion are given in Appendix B. These lists are a subset of the *National List of Plant Species that Occur in Wetlands* (Reed 1988) and do not include any proposed changes in wetland indicator statuses. There is an interagency effort underway to subregionalize the Alaska plant list, which should help to improve the accuracy of hydrophytic vegetation determinations across the state. For Clean Water Act purposes, wetland delineators should use the latest plant lists approved by Headquarters, U.S. Army Corps of Engineers.

Guidance on Vegetation Sampling

General guidance on sampling of vegetation for wetland-delineation purposes is given in the Corps Manual for both the Routine and Comprehensive methods. Those procedures are intended to be flexible and often need to be modified for application in a given region or on a particular site. The following guidance on vegetation sampling is intended to supplement the Corps Manual for applications in Alaska.

Vegetation sampling done as part of a wetland delineation is designed to characterize the site in question rapidly without the need for detailed scientific study or statistical methods. A balance must be struck between the need to accomplish the work quickly and the need to characterize the site's heterogeneity accurately and at an appropriate scale.

The first step is to stratify the site so that the major landscape forms can be evaluated separately. This may be done using an aerial photograph or topographic map ahead of time or by walking over the site sufficiently to identify vegetation units associated with key landscape forms. In general, routine wetland determinations are based on visual estimates of percent cover of plant

species that can be made either (1) within the vegetation unit as a whole, or (2) within one or more sampling plots established in representative locations within each unit. Percent cover estimates are more accurate and repeatable if taken within a defined plot. This also facilitates field verification of another delineator's work. The sizes and shapes of plots, if used, may be modified as appropriate to adapt to site conditions and should be recorded on the field data form. Near the wetland boundary, it may be necessary to adjust plot size or shape to avoid overlapping the boundary and extending into an adjacent community having different vegetation, soils, or hydrologic conditions. If the site is topographically diverse, procedures for wetland/non-wetland mosaics may be needed (see Chapter 5).

If it is not possible to locate one or a few plots in a way that adequately represents the landscape unit being sampled, then percent cover estimates can be made by walking the unit and visually estimating the coverage of each species over a broader area. If additional quantification of cover estimates is needed, point-intercept sampling along transects (see the following optional procedure) may be used to characterize the vegetation within a landscape unit, as long as soil and hydrologic conditions are uniform across the area.

Optional procedure for point-intercept sampling

Vegetation sampling can be difficult in communities that are highly diverse or have heterogeneous plant cover. This can create a problem for the wetland delineator, particularly in areas where the hydrophytic vegetation determination may be borderline. In these cases, it may be necessary to use a more accurate and repeatable assessment of cover. In point-intercept sampling, plant occurrence is determined at points located at fixed intervals along one or more transects established in random locations within the plant community. If a transect is being used to sample the vegetation near a wetland boundary, the transect should be placed parallel to the wetland boundary and should not cross either the wetland boundary or into other communities. Usually a tape measure is laid on the ground and used for the transect line. Transect length depends upon the size and complexity of the plant community and may range from 100 to 300 ft (30 to 90 m) or more. Plant occurrence data are collected at fixed intervals along the line, for example every 2 ft (0.6 m). At each interval, a "hit" on a species is recorded if a vertical line at that point would intercept the stem or foliage of that species. Only one "hit" is recorded for a species at a point even if the same species would be intercepted more than once at that point. Vertical intercepts can be determined using a long pin or rod protruding into and through the various vegetation layers, a sighting device (e.g., for the canopy), or an imaginary vertical line. The total number of "hits" for each species along the transect is then determined. The result is a list of species and their frequencies of occurrence along the line (Mueller-Dombois and Ellenberg 1974, Tiner 1999). Species are then categorized by wetland indicator status (i.e., OBL, FACW, FAC, FACU, or UPL) and the data used to calculate a transect-based prevalence index. The formula is similar to that given later in this chapter for the plot-based prevalence index (Indicator 1), except that frequencies are used in place of cover estimates. The community is hydrophytic if the prevalence index is ≤3.0. To be

valid, more than 80 percent of “hits” on the transect must be of species that have been identified correctly and placed in an indicator category.

Calculate the transect-based prevalence index using the following formula:

$$PI = \frac{F_{OBL} + 2F_{FACW} + 3F_{FAC} + 4F_{FACU} + 5F_{UPL}}{F_{OBL} + F_{FACW} + F_{FAC} + F_{FACU} + F_{UPL}}$$

where:

PI = Prevalence index
F_{OBL} = Frequency of obligate (OBL) plant species
F_{FACW} = Frequency of facultative wetland (FACW) plant species
F_{FAC} = Frequency of facultative (FAC) plant species
F_{FACU} = Frequency of facultative upland (FACU) plant species
F_{UPL} = Frequency of upland (UPL) plant species

Sampling wetland cryptogams

Background. Cryptogams, defined here as bryophytes (mosses, liverworts, hornworts), lichens, and fungi, form extensive ground cover in boreal forest, alpine, and polar ecosystems in Alaska (Figure 1). The cryptogam flora of Alaska is diverse and the identification of species can at times be challenging even to experts due to ephemeral or missing fruiting structures and minute differences in morphological characteristics. However, Laursen, Seppelt, and Zhurbenko (2005) and Lichvar et al. (2006, in prep.) have developed a list of common and relatively easy-to-identify species that are highly associated with wetlands. The Corps Manual does not specifically include cryptogams in hydrophytic vegetation decisions. However, in this regional supplement, the presence and abundance of certain wetland cryptogams are used as positive indicators of hydrophytic vegetation in situations where indicators of hydric soil and wetland hydrology are also present.

Figure 1. Typical complex spatial arrangement of cryptogams within a moss blanket

These studies focused on black spruce wetlands in Interior and Southcentral Alaska, and identified cryptogam species that were strongly associated with wetlands and, when sufficiently abundant, constitute a nearly “test positive” indicator of hydrophytic vegetation. Wetland-specialist bryophytes were defined as those having ≥67 percent frequency of occurrence in these wetland types. When one or more of these species comprise >50 percent of the total bryophyte cover, the cryptogam indicator has a >90 percent probability of association with

wetlands. Bryophytes supporting the cryptogam indicator are presented in Table 2.

Table 2
Bryophytes That Are Highly Associated with Wetlands in Interior and Southcentral Alaska

Aulacomnium palustre	*Rhizomnium punctatum*
Blepharostoma trichophyllum (hepatic)	*Sphagnum angustifolium*
Bryum pseudotriquetrum	*Sphagnum fuscum*
Calliergon stramineum	*Sphagnum papillosum*
Calypogeia spp. (hepatic)	*Sphagnum russowii*
Drepanocladus spp.	*Sphagnum squarrosum*
Meesia triquetra	*Sphagnum warnstorfii*
Meesia ulignosa	*Sphagnum squarrosum*
Mylia anomala (hepatic)	*Tomenthypnum nitens*
Pohlia proligera	

Plot Size. To determine whether hydrophytic vegetation is present using the cryptogam layer, areal cover estimates are recorded for all bryophytes within a plot. Due to the sorting of different species on the tops of hummocks versus the swales, sampling of cryptogams is restricted to the swales located between and at the base of hummocks using a 10- by 10-in. (25- by 25-cm) quadrat. To ensure that the sampling plots adequately capture species diversity, three cryptogam quadrats are suggested, placed around the base of the hummocks, if space is available. Data from these three plots can be combined and averaged to determine if the cryptogam indicator is met.

Hydrophytic Vegetation Indicators

The following indicators should be applied in the sequence presented. Hydrophytic vegetation is present if any of the indicators is satisfied. However, some indicators have the additional requirement that indicators of hydric soil and wetland hydrology must also be present. These indicators are applicable throughout Alaska.

The Prevalence Index (Indicator 1) is the basic hydrophytic vegetation indicator in Alaska and should be applied in every wetland determination. (At the discretion of the Corps of Engineers Alaska District, an alternative hydrophytic vegetation indicator based on the wetland indicator status of dominant plant species may also be used in certain limited situations. See Appendix C for more information.) Most wetlands in Alaska have plant communities that will meet Indicator 1, and this is the only indicator that needs to be used in most situations. However, some unusual wetland communities may fail Indicator 1 due to the prevalence of FACU species even on clearly wet sites. In those cases, if indicators of hydric soil and wetland hydrology are both present, then the vegetation should be reevaluated using Indicator 2 (Wetland Cryptogams) or Indicator 3 (Morphological Adaptations). Finally, certain

problematic wetland situations may lack any of these indicators and are described in Chapter 5. The procedure for using hydrophytic vegetation indicators is as follows:

1. Calculate the prevalence index (Indicator 1) first.
   a. If the prevalence index is ≤3.0, then the vegetation is hydrophytic and no further vegetation analysis is required.
   b. If the plant community fails the prevalence index, and indicators of hydric soil and/or wetland hydrology are absent, then hydrophytic vegetation is absent unless the site meets requirements for a problematic wetland situation (see Chapter 5).
   c. If the plant community fails the prevalence index, but indicators of hydric soil and wetland hydrology are both present, proceed to the next step.
2. Apply Indicators 2 (Wetland Cryptogams) and 3 (Morphological Adaptations). This step assumes that at least one indicator of hydric soil and one primary or two secondary indicators of wetland hydrology are present.
   a. If either Indicator 2 or Indicator 3 is satisfied, then the vegetation is hydrophytic.
   b. If neither of the indicators is satisfied, then hydrophytic vegetation is absent unless the site meets the requirements for a problematic wetland situation (Chapter 5).

Indicator 1: Prevalence index

Description: The prevalence index is ≤3.0.

User Notes: At least 80 percent of the total vegetation cover on the plot must be of species that have been correctly identified and have an assigned wetland indicator status.

Procedure for Calculating a Plot-Based Prevalence Index: The prevalence index is a weighted-average wetland indicator status of all plant species in the sampling plot or other sampling unit, where each indicator status category is given a numeric code (OBL = 1, FACW = 2, FAC = 3, FACU = 4, and UPL = 5) and weighting is by abundance (percent cover). It is a more comprehensive analysis of the hydrophytic status of the community than one based on just a few dominant species. The method was described by Wentworth, Johnson, and Kologiski (1988) and modified by Wakeley and Lichvar (1997). It uses percent cover estimates for each plant species in the plot, with the constraint that at least 80 percent of the total vegetation cover on the plot must be of species that have been correctly identified and have an assigned wetland indicator status. The following procedure is used to calculate a plot-based prevalence index:

1. Identify and estimate the absolute percent cover of each species in the community. These estimates should be made without regard to vegetation layering or strata.
2. Organize all species into groups according to their wetland indicator status (i.e., OBL, FACW, FAC, FACU, or UPL) and sum their cover

values within groups. Do not include species that were not identified. Species that were identified correctly but are not listed on the wetland plant list are assumed to be upland (UPL) species. For species with no regional indicator (NI), do not use the species to calculate the prevalence index.

3. Calculate the prevalence index using the following formula:

$$PI = \frac{A_{OBL} + 2A_{FACW} + 3A_{FAC} + 4A_{FACU} + 5A_{UPL}}{A_{OBL} + A_{FACW} + A_{FAC} + A_{FACU} + A_{UPL}}$$

where:

PI = Prevalence index
A_{OBL} = Summed percent cover values of obligate (OBL) plant species
A_{FACW} = Summed percent cover values of facultative wetland (FACW) plant species
A_{FAC} = Summed percent cover values of facultative (FAC) plant species
A_{FACU} = Summed percent cover values of facultative upland (FACU) plant species
A_{UPL} = Summed percent cover values of upland (UPL) plant species

The prevalence index should range between 1 and 5. See Table 3 for an example calculation of the prevalence index. The following web link provides free public-domain software for simultaneous calculation of the prevalence index and alternative indicators based on dominant species (see Appendix C): http://www.crrel.usace.army.mil/rsgisc/wetshed/wetdatashed.htm.

Table 3
Example of the Prevalence Index

Indicator Status Group	Species Name	Percent Cover by Species	Total Cover by Group	Multiply by:[1]	Product
OBL species	None	0	0	1	0
FACW species	*Matteuccia struthiopteris* *Impatiens noli-tangere*	40 20	60	2	120
FAC species	*Ribes hudsonianum* *Calamagrostis canadensis* *Streptopus amplexifolius* *Salix alaxensis* *Alnus sinuata*	10 5 5 80 10	110	3	330
FACU species	*Equisetum arvense* *Thalictrum sparsiflorum* *Dryopteris dilatata* *Oplopanax horridus* *Populus balsamifera*	10 10 5 5 20	50	4	200
UPL species	None	0	0	5	0
Sum			220 (A)		650 (B)
Hydrophytic Vegetation Determination		Prevalence Index = B/A = 650/220 = 2.95 Therefore, this community is hydrophytic by Indicator 1 (Prevalence Index).			

[1] Where OBL = 1, FACW = 2, FAC = 3, FACU = 4, and UPL = 5.

Indicator 2: Wetland cryptogams

Description: >50 percent of the total coverage of bryophytes consists of species known to be highly associated with wetlands (Table 2).

User Notes: This indicator is based on the presence and abundance of a select group of wetland specialist bryophytes that are specific to black spruce forests in Interior and Southcentral Alaska. The indicator may also be applicable in other parts of the state but has not been tested there. To satisfy this indicator, the summed cover value for wetland specialist bryophytes must be >50 percent of the total bryophyte cover in the plot. Follow this procedure:

1. Estimate the total cover of bryophytes (mosses, liverworts, and hornworts) within one or more 10- by 10-in. (25- by 25-cm) square plots placed at the base of any hummocks, if present. Lichens and fungi should not be included.
2. Estimate the percent cover for each of the wetland specialist bryophytes (Table 2) present and sum their cover values within plots.
3. Divide the summed cover value of wetland specialist bryophytes by the total bryophyte cover in the plot and multiply by 100 to convert to a percentage. Average these percentages across plots, if needed.
4. If >50 percent of the bryophyte layer consists of wetland specialists, then the vegetation is hydrophytic.

Indicator 3: Morphological adaptations

Description: The plant community passes Indicator 1 (Prevalence Index) after reconsideration of the indicator status of certain plants that exhibit morphological adaptations for life in wetlands.

User Notes: Some hydrophytes in Alaska develop easily recognized physical characteristics, or morphological adaptations, when they occur in wetland areas. These adaptations may help them to survive prolonged inundation or saturation in the root zone, or they may simply be a consequence of living under such wet conditions. The most common morphological responses to wetland conditions in Alaska are changes in growth form of certain plants, such as stunting or reduced vigor due to stress. Morphological adaptations may develop on FACU species when they occur in wetlands, indicating that those individuals are capable of functioning as hydrophytes. Examples of growth form responses for common species encountered during wetland determinations in Alaska are given in Table 4.

Table 4 **Stress/Vigor Examples for Four Species Frequently Encountered During Wetland Determinations in Alaska**	
Species	**Growth Form Response**
Betula papyifera (paper birch)	Stressed trees growing in wet conditions tend to be stunted, have multiple trunks, have an “apple tree” like growth form, are reduced in size, and many times have a rotten core in the tree trunk.
Picea glauca (white spruce)	Under wet conditions, the needles are farther apart, branching is less bushy, and the growth form more narrow in shape.
Picea mariana (black spruce)	Under wet conditions, trees have a shorter stature, asymmetrical shape, narrower growth form, and reduced volume for their age. On drier sites, the growth form is large and has an appearance similar to white spruce.
Picea sitchensis (Sitka spruce)	Under wet conditions, the main growth response is stunting.

To apply this indicator, these morphological features must be observed on >50 percent of the individuals of a FACU species living in an area where indicators of hydric soil and wetland hydrology are present. Follow this procedure:

1. Confirm that the morphological feature is present mainly in the potential wetland area and is not also common on the same species in the surrounding uplands.
2. For each FACU species that exhibits morphological adaptations, estimate the percentage of individuals that have the features. Record this percentage on the data form.
3. If >50 percent of the individuals of a FACU species have morphological adaptations for life in wetlands, that species is considered to be a hydrophyte and its indicator status on that plot should be reassigned as FAC. All other species retain their published indicator statuses. Record any supporting information on the data sheet, including a description of the morphological adaptation(s) present and any other observations of the growth habit of the species in adjacent wetland and upland locations (photo documentation is recommended).
4. Recalculate the prevalence index (Indicator 1) using an FAC indicator status for this species. The vegetation is hydrophytic if the prevalence index is ≤3.0.

3 Hydric Soil Indicators

Introduction

The National Technical Committee for Hydric Soils (NTCHS) defines a hydric soil as a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (USDA Soil Conservation Service 1994). Nearly all hydric soils exhibit characteristic morphologies that result from repeated periods of saturation or inundation for more than a few days. Saturation or inundation, when combined with microbial activity in the soil, causes the depletion of oxygen. Anaerobiosis promotes certain biogeochemical processes, such as the accumulation of organic matter and the reduction, translocation, or accumulation of iron and other reducible elements. These processes result in characteristic morphologies that persist in the soil during both wet and dry periods, making them particularly useful for identifying hydric soils in the field (USDA Natural Resources Conservation Service, in press).

This chapter presents indicators that are designed to help identify and delineate hydric soils in Alaska. This group of hydric soil indicators is a subset of the NTCHS *Field Indicators of Hydric Soils in the United States* (USDA Natural Resources Conservation Service, in press) that are commonly found in Alaska. A change to an indicator by the NTCHS represents a change to this subset of indicators for Alaska. This list of indicators is dynamic; changes and additions are anticipated with new research and field testing. To use the indicators properly, a basic knowledge of soil/landscape relationships is necessary. Furthermore, indicators are not intended to replace or relieve the requirements contained in the definition of a hydric soil given above.

All of the indicators presented here are applicable statewide although some are more common in certain subregions. The User Notes for each indicator provide information specific to each subregion. Subregions mentioned in this supplement are equivalent to the Land Resource Regions (LRR) in Alaska recognized by the USDA Natural Resources Conservation Service (2004) with the exception that the Southern Alaska LRR has been split into Southcentral and Southeast subregions (see Appendix B). It is important to note that boundaries between subregions are actually broad transition zones and that soil and landscape conditions do not change abruptly at the boundary.

The indicators are used to help identify the hydric soil component of wetlands; however, some hydric soils do not have any of the currently listed indicators. The absence of any listed indicator does not preclude the soil from being hydric. Guidance for identifying hydric soils that lack indicators is given in Chapter 5, "Difficult Wetland Situations in Alaska."

Notes on Alaska Soils

The following background information on soil development in Alaska and guidance for soil sampling was adapted from USDA Natural Resources Conservation Service (2005a).

Organic matter accumulation

Saturated or inundated soils. Since the efficiency of soil microbes is considerably lower in a saturated and anaerobic environment, less organic matter and organic carbon is consumed by the microbes. Organic matter and carbon begin to accumulate. The result is the development of thick organic surfaces on the soil (Figure 2) or dark organic-rich surface mineral layers.

Figure 2. A saturated organic soil. In this profile, saturated organic material extends from the soil surface to a depth below 24 in. (60 cm)

Non-saturated or non-inundated soils. Cool temperatures and acid conditions result in the slow decomposition of organic matter. Therefore, many well-drained soils in Alaska, under aerobic conditions, have thick organic surface layers called Folists or folistic epipedons. These layers are not an indication of diminished microbial activity in a saturated anaerobic environment. Folistic layers are organic accumulations that do not saturate for more than 30 days and, in many cases, do not saturate during most years. Most folistic layers are comprised of poorly decomposed organic material and usually are found in forested areas with greater than 10 percent slopes. Folistic surface layers may overlie rock, a mineral layer, or saturated organic layers. Saturated organics, if underlying an unsaturated organic layer, will usually be more decomposed and have a greasy feel when rubbed between the fingers. It may be necessary to involve a soil scientist with local knowledge to distinguish folistic surface layers from saturated organic layers.

Iron reduction, translocation, and accumulation

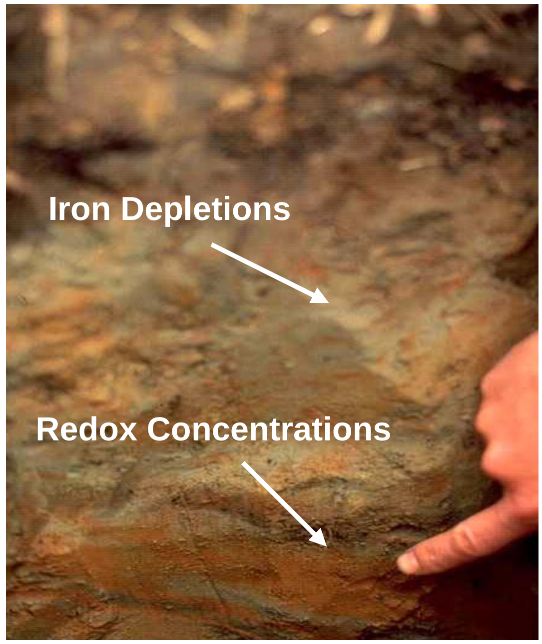

Figure 3. Iron depletions and redox concentrations in a hydric soil

Saturated or inundated soils. In an anaerobic environment, soil microbes reduce ferric iron (Fe^{+3}) to ferrous iron (Fe^{+2}). Areas in the soil where iron is reduced develop characteristic bluish-gray or greenish-gray colors known as *gley.* Ferric iron is insoluble but ferrous iron easily enters the soil solution and is moved or translocated to other areas of the soil. Areas that have lost iron develop characteristic whitish-gray or reddish-gray colors and are known as *iron depletions.* If a soil reverts to an aerobic state, iron that is in solution will oxidize and become concentrated in patches and along pores and root channels. These areas of oxidized iron are called *redox concentrations.* Since water movement in these saturated or inundated soils can be multi-directional, iron depletions and redox concentrations can occur anywhere in the soil (Figure 3). Zones that are iron-depleted due to saturation and reduction normally occur as irregularly shaped or discontinuous patches and zones. Redox concentrations occur either as discontinuous patches or along root channels and pores.

Non-saturated or non-inundated soils. In well-drained, aerated soils, iron translocation is also a normal process. Infiltration moves downward through the soil and together with the presence of organic acids, leaches or washes iron from mineral layers near the top of the soil. The iron moves in solution downward and accumulates in lower layers. As the near-surface layers are continually leached, their colors become similar to those of iron depletions. The accumulation of iron in the lower horizons may result in colors similar to redox concentrations. This coloration is most pronounced in Spodosols.

Spodosols (Figure 4) form in relatively acidic soil material. Spodosols can be either hydric or non-hydric. They are most common in forested areas or upper mountain slopes in southern Alaska but also occur elsewhere. Organic carbon, iron, and aluminum are leached from a layer near the soil surface. This layer, known as the E horizon, has a bleached light-gray appearance and consists of relatively clean particles of sand and silt. The materials leached from the E horizon are deposited lower in the soil in the Spodic horizon (Bhs or Bs horizon). If sufficient iron has been leached and redeposited, the spodic horizon will have a strong reddish color. In some Spodosols, both E horizon and spodic horizon

colors may be confused with the iron depletions and redox concentrations that result from anaerobic soil conditions.

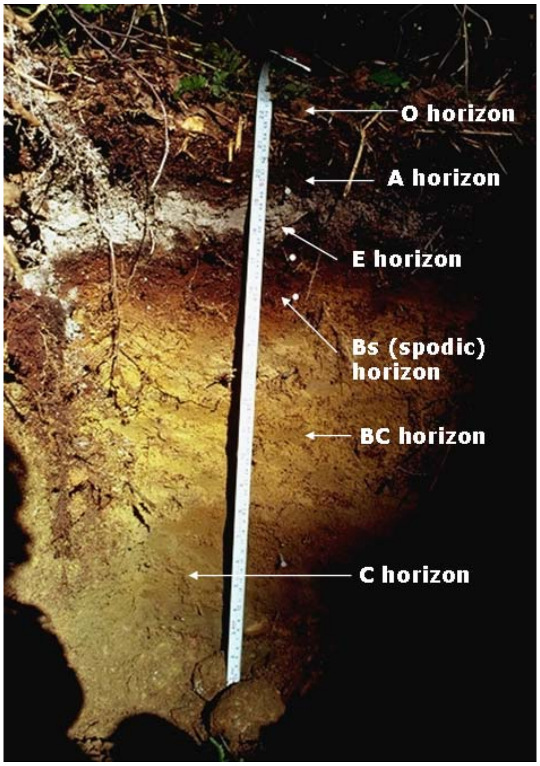

Figure 4. Example of a non-hydric Spodosol

Normally, E horizon and spodic horizon material are present in the soil in relatively continuous horizontal bands (Figure 4). Chemical weathering in an aerated soil is accomplished by the downward movement of water; therefore, the layers or horizons are relatively parallel to the soil surface and consistent across the soil. Transitions are relatively abrupt between the organic surface, the leached E horizon, and the iron-enriched B horizon. Below the B horizon, the transition becomes more gradual with the red hue of the iron-enriched B horizon gradually changing to the yellower hue of the underlying C horizon.

If E horizons are thin or there are extensive plant roots, however, they may be discontinuous. Tree throw and cryoturbation can also mix and break the horizons of aerated upland soils (Figure 5), so care should be taken to examine all site characteristics before concluding that a soil is hydric.

Figure 5. A well-drained Spodosol with strong E and Bh or spodic horizons. Horizons have been broken and mixed by tree throw. Care is needed not to confuse these with iron depletions and redox concentrations caused by soil saturation and anaerobiosis

Confusing redox concentrations

Some soils have obvious redox concentrations but the site has little or no evidence of wetland hydrology or vegetation. These include the following situations:

Seasonal-frost affected soils. Seasonal frost is prevalent in areas with little snow cover or where wind commonly removes the snow cover. The seasonal frost forms a nearly impermeable layer similar to permafrost. During break-up, melt water perches on the seasonal frost layer, often resulting in near-surface saturation or ponding. The seasonal frost then degrades within one to two weeks and the soil's normal permeability resumes. The saturated conditions often result in redoximorphic features in the soil (Figure 6). True gley colors rapidly change to non-gley hues once oxidation is present, although redox concentrations remain.

Figure 6. Redox concentrations formed as a result of melt water perching on seasonal frost

Many of these soils are hydric, although they occur on landscape positions that are normally considered to be well-drained uplands. It is critical to observe carefully and note all other site characteristics, including indicators of hydrophytic vegetation and wetland hydrology, before classifying the area as either wetland or non-wetland.

Thawed permafrost-affected soils. In most soils affected by permafrost, the permafrost forms a restrictive layer that will perch water. In many such soils, the active layer above the permafrost table is saturated long enough during the growing season so that reduced conditions occur. Redoximorphic features and hydric soil indicators are often present (Figure 7).

Figure 7. Thawed permafrost-affected soil. Redox concentrations remain 25 years after drainage improved

If a natural or cultural activity, such as wildfire or land clearing, disturbs the surface organic layer, the temperature of a permafrost-affected soil may increase. This increase can result in enough thawing that the restrictive permafrost layer is

either lowered in the soil profile or completely removed. If the soil occurs in an upland position and has no other restrictive layers, drainage can improve significantly. Similar to soils affected by seasonal frost, gley colors will alter to non-gley hues, but redox concentrations will persist. Therefore, hydric soil indicators may be present even though wetland hydrology has been lost. It is critical to observe carefully and note all other site characteristics, including vegetation and hydrology, before making the wetland determination.

Cautions

A soil that is artificially drained or protected (for instance, by levees) is hydric if the soil in its undisturbed state would meet the definition of a hydric soil. To be determined hydric, these soils should generally have one or more of the indicators.

Morphological features of hydric soils indicate that saturation and anaerobic conditions have existed under either contemporary or recent hydrologic conditions. Features that do not reflect contemporary or recent hydrologic conditions of saturation and anaerobiosis are relict features. Typically, contemporary and recent hydric soil features have diffuse boundaries; relict hydric soil features have abrupt boundaries. When soil morphology seems inconsistent with the landscape, vegetation, or observable hydrology, it may be necessary to obtain the assistance of an experienced soil or wetland scientist to determine whether soil features are relict.

Procedures for Sampling Soils

Observe and document the site

The common temptation is to excavate a small hole in the soil, note the presence of any indicators, make a decision, and leave. Before any decision can be made, however, the overall site and how it interacts with the soil must be understood. The following procedure can improve the accuracy of hydric soil and wetland decisions.

At each site, examine the following site features before looking for hydric soil indicators. Use all of the evidence available. If one or more of the listed soil indicators is present, the soil is hydric. Use the additional information about the site to understand why the soil is hydric. If no hydric soil indicators are present, use the additional site information to determine if the soil is indeed non-hydric or if it represents a 'problem' hydric soil.

- *Hydrology*–Is standing water observed on the site or is water observed in the soil pit? What is the water table depth in the area?
- *Slope*–Is the site level or nearly level so that surface water does not run off readily, or is it steeper where surface water would run off from the soil?

- *Slope shape*–Is the surface concave, where water would tend to collect and possibly pond on the soil surface? On hillsides, are there convergent slopes, where surface or groundwater may be directed toward a central stream or swale, or is the surface or slope shape convex, causing water to run off or disperse?
- *Landform*–Is the soil on a low terrace or floodplain, which would be subject to seasonal high water tables or flooding? Is it at the toe of a slope where runoff may tend to collect or groundwater may discharge at or near the surface?
- *Soil materials*–Is there a restrictive layer in the soil that would slow or prevent the infiltration of water? This could include permafrost, consolidated bedrock, a layer of silt, substantial clay content, or dense glacial till. Alternatively, is there relatively loose soil material (sand, gravel, or rocks) or fractured bedrock that would allow the soil to drain readily?
- *Vegetation*–Does the vegetation at the site indicate wetter conditions than at other nearby sites, or is it similar to that found on nearby nonwetland sites?

The questions above should be considered at every site. Always look at the features of the immediate site and compare them to surrounding areas. Try to contrast the features of wet and dry sites that are in close proximity. When observing slope features, look first at the area immediately around the sampling point. A nearly level bench or depression at the immediate site may be more important to site wetness than the overall hillslope on which it occurs. Only by understanding the overall site can the investigator understand the presence or absence of indicators in the soil.

Observe and document the soil

To document a hydric soil, first remove all loose leaves, needles, or bark from the soil surface. Do not remove the organic surface layers of the soil, which usually consist of dead moss and other plant remains in varying stages of decomposition. Dig a hole and describe the soil profile to a depth of at least 20 in. (50 cm) from the soil surface, unless bedrock is found at a shallower depth. Use the completed soil profile description to determine which indicators have been matched.

Deeper examination of the soil may be required when field indicators are not easily seen within 20 in. (50 cm) of the surface. It is always recommended that soils be excavated and described as deep as necessary to make reliable interpretations. For example, examination to less than 20 in. (50 cm) may suffice in soils with surface horizons of saturated organic material. Conversely, the excavation depth will often need to be greater than 20 in. (50 cm) in soils with thick dark surface horizons because the upper horizons of these soils, due to the masking effect of organic material, often contain no easily visible redoximorphic features. At many sites, it is necessary to make exploratory observations to 40 in. (1 m) or more. These observations should be made with the intent of

documenting and understanding the variability in soil properties and hydrologic relationships on the site.

Whenever possible, excavate the soil deep enough to determine if there are layers or materials present that might restrict soil drainage. This will help to understand why the soil may or may not be hydric.

To determine if a hydric soil indicator is present, it is critical to know exactly where to begin looking. All of the indicators require the presence of certain soil colors or features within specified depths from the soil surface. For the purpose of identifying hydric soils in Alaska, the soil surface begins at the top of the first mineral layer (underneath any and all organic material) except for the application of indicators A1 – Histosol or Histel and A2 – Histic Epipedon. For A1 and A2, the soil surface starts just below the living, green moss layer. The majority of Alaska soils have an organic surface layer.

All colors noted in this supplement refer to moist Munsell colors. Soil colors specified in the indicators do not have decimal points; however, intermediate colors do occur between Munsell chips. Soil chroma should not be rounded to qualify as meeting an indicator. For example, a soil matrix with a chroma between 2 and 3 should be listed as having a chroma of 2+. This soil material does not have a chroma of 2 and would not meet any indicator that requires a chroma of 2 or less.

Particular attention should be paid to changes in microtopography over short distances. Small changes in slope configuration may result in repetitive sequences of hydric/non-hydric soils, and the delineation of individual areas of hydric and non-hydric soils may be difficult. Often the dominant condition, either hydric or non-hydric, is the only reliable interpretation. The shape of the local landform can greatly affect the movement of water through the landscape. Significant changes in parent material or lithologic discontinuities in the soil can also affect the hydrologic properties of the soil. After a sufficient number of exploratory excavations have been made to understand the soil-hydrologic relationships at the site, subsequent excavations can be limited to the depth needed to identify hydric soil indicators.

Take photos of both the soil and the overall site. There may be no opportunity to return for more data.

Hydric Soil Indicators

Indicator A1: Histosol or Histel

Technical Description: Classifies as a Histosol (except Folists) or as a Histel (except Folistels).

User Notes: Histosols are soils usually having 16 in. (40 cm) or more of saturated organic material measured from the soil surface (Figure 8). Histels are

simply Histosols that have permafrost in the soil profile, so some part of the organic material may be permanently frozen. Peak periods for observing saturation in each subregion are given below. Organic surfaces without evidence of saturation are excluded if not artificially drained (Folists and Folistels).

Figure 8. Example of a Histosol. This soil has saturated organic materials extending from the soil surface to a depth of more than 24 in. (60 cm)

The best evidence of saturation is the presence of a water table within the organic layer during at least part of the growing season. Saturation should be observable during peak periods within each subregion (see below) or may be inferred from wetland hydrology indicators outside of the peak period. Thin mineral strata may be observed within the organic layer. In some locations, ash deposits may overlie the organic material. These soils may or may not contain permafrost.

Aleutian Alaska. Saturation is likely to be observed throughout the year. Saturated organic deposits commonly occur in depressions and flats.

Interior Alaska. Saturation is most likely during May and late July-September. Saturated organic deposits commonly occur in groundwater discharge zones in depressions and flats and extensively across backslopes where restrictive layers (e.g., permafrost, glacial till) in the soil perch water.

Northern Alaska. Saturation is most likely during June-August. Saturated organic deposits commonly occur in coastal plains, depressions, slopes on the foothills, and on floodplains (Figure 9) where restrictive layers (e.g., permafrost, glacial till) in the soil perch water.

Figure 9. Soils with thick, saturated organic surfaces normally occur in concave or plain landform positions. Areas may range in size from very small depressions on backslopes to large fens and bogs. Usually a restrictive layer, such as glacial till or permafrost, impedes the downward movement of water

Southcentral Alaska. Saturation is most likely to be observed during April-May and September-October. Saturated organic deposits commonly occur in groundwater discharge zones along toeslopes and footslopes where restrictive layers (e.g., glacial till) in the soil perch water. This indicator also occurs in depressions and along tidal fringes.

Southeast Alaska. Saturation is most likely to be observed during April-May and September-October. Saturated organic deposits commonly occur in groundwater discharge zones and where restrictive layers (e.g., bedrock, glacial till) in the soil perch water.

Western Alaska. Saturation is most likely during May-September. Saturated organic deposits commonly occur in groundwater discharge zones in depressions and flats, and extensively across backslopes where restrictive layers (e.g., permafrost, glacial till) in the soil perch water.

Indicator A2: Histic Epipedon

Technical Description: A histic epipedon.

User Notes: Most histic epipedons are surface horizons 8 in. (20 cm) or more thick of saturated organic material (Figure 10). The intent of this indicator is to identify saturated organic accumulations generally 8-16 in. (20-40 cm) thick that

are not as thick as those described in Indicator A1 – Histosol or Histel. A histic epipedon must be saturated in all or part of the layer at some time in most years. The best evidence of saturation is the presence of a water table during at least part of the growing season. Saturation should be observable during peak periods within each subregion (see Indicator A1) or may be inferred from wetland hydrology indicators outside of the peak period. Thin mineral strata may be observed within the organic layers. In some locations, ash deposits may overlie the organic material. These soils may or may not contain permafrost. Organic surfaces without evidence of saturation are excluded if not artificially drained.

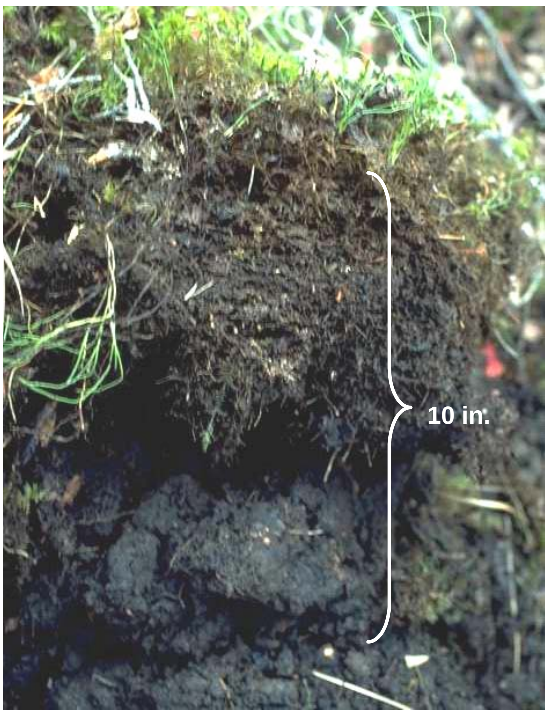

Figure 10. A histic epipedon consisting of saturated organic material overlying mineral soil. The saturated organic material extends from the soil surface to a depth of approximately 10 in. (25 cm)

Indicator A4: Hydrogen Sulfide

Technical Description: A hydrogen sulfide odor within 12 in. (30 cm) of the soil surface.

User Notes: These soils are usually permanently saturated and anaerobic at or near the surface. Any time the excavated soil smells of hydrogen sulfide (rotten egg odor), sulfur is currently being reduced and the soil is definitely in an anaerobic state. In some soils, the odor is well pronounced; in others, it is very fleeting and the gas rapidly dissipates. If in doubt, quickly open several small holes in the area of concern to determine if a hydrogen sulfide odor is present.

Indicator A12: Thick Dark Surface

Technical Description: A mineral layer at least 6 in. (15 cm) thick with a depleted matrix that has 60 percent or more chroma 2 or less (or a gleyed matrix) starting below 12 in. (30 cm) of the surface. The layer(s) above the depleted or gleyed matrix have value 2.5 or less and chroma 1 or less to a depth of 12 in. (30 cm) and value 3 or less and chroma 1 or less in the remainder of the epipedon. If the epipedon is sandy, at least 70 percent of the visible soil particles must be covered, coated, or similarly masked with organic material.

User Notes: Accumulation of organic carbon in mineral soil layers results in dark colors. Thicker dark surfaces are common in depressional areas where moisture accumulates and plant growth is enhanced. The thicker dark surfaces do not necessarily indicate saturation. However, if saturation does occur, the thick dark surface may mask or hide evidence of reduction near the soil surface. Look for two things. One is evidence of a depleted or gleyed matrix below the dark surface material (see the Glossary for definitions of depleted and gleyed matrix). The other is a source of saturation. This may include a restrictive layer that perches precipitation and snowmelt, a nearby spring or seep, or a snowfield that persists late into the summer (see Indicator TA5, Alaska Alpine Swales). Use of this indicator requires close observation and an understanding of landform position and local sources of hydrology.

This indicator is used for soils with thick, very dark surface mineral horizons that mask reduction features (Figure 11). Visible evidence of gley may only be observable deeper in the soil. Look below 12 in. (30 cm) for evidence of a depleted or gleyed matrix.

Since some soils with thick dark surfaces are Spodosols, extreme care must be taken not to confuse grayish colored E horizon material with depleted colors. In addition, glacial deposits or marine sediments underlie some Alaska soils. These parent materials have base colors that can easily be confused with gleyed colors. Look for redox concentrations along pores and root channels (Indicator A14, Alaska Redox) and/or gleyed root channels (Indicator A15, Alaska Gleyed Pores) below 12 in. (30 cm).

Figure 11. A depleted matrix begins at approximately 14 in. (35 cm) below a dark surface mineral layer

Aleutian Alaska. This indicator is not known to occur in the subregion.

Interior Alaska. Saturation is most likely to be observed during April-May and September-October. This is a common indicator on mountain slopes where restrictive layers in the soil perch seasonal water tables. This indicator does not occur in permafrost-affected soils.

Northern Alaska. Saturation is most likely to be observed during June-August. This is a common indicator on mountain slopes where restrictive layers in the soil perch seasonal water tables.

Southcentral Alaska. Saturation is most likely to be observed during April-May and September-October. This is a common indicator on mountain slopes where restrictive layers in the soil perch seasonal water tables.

Southeast Alaska. This indicator is not known to occur in the subregion.

Western Alaska. Saturation is most likely to be observed during April-May and September-October. This is a common indicator on mountain slopes where restrictive layers in the soil perch seasonal water tables. This indicator does not occur in permafrost-affected soils.

Indicator A13: Alaska Gleyed

Technical Description: A mineral layer with a gleyed matrix that occupies 50 percent or more of a layer that starts within 12 in. (30 cm) of the soil surface. The gleyed matrix is underlain within 60 in. (1.5 m) of the soil surface by soil material with hue 5Y or redder that is the same type of parent material.

User Notes: This indicator has two requirements. First, within 12 in. (30 cm) of the soil surface, a layer having one or more of the specified gleyed colors is present (see the Glossary for the definition of gleyed matrix). These colors can be found on the gleyed 1 and gleyed 2 pages of the Munsell color book (Gretag/Macbeth 2000). Second, below these gleyed colors, the color of similar soil material is hue 5Y or redder (i.e., 2.5Y, 10YR, 7.5YR, etc.). If the gleyed colors extend beyond a depth of 60 in. (1.5 m), the true color of the parent material cannot be determined. In that case, try applying Indicator A14 (Alaska Redox). The presence of gleyed colors indicates that the soil has undergone reduction. The requirement for 5Y or redder colors lower in the profile is to ensure that the gleyed colors are not simply the basic color of the soil parent material. This indicator proves that the near-surface gleyed colors are not natural soil material colors, and that they are the result of reduced conditions. When comparing near-surface and underlying colors, make sure that the type of soil material is the same (Figures 12 and 13). Many soils in Alaska are composed of two or more types of material (e.g., silty loess overlying gravelly glacial till or sand-and-gravel river deposits). Tidal sediments, lacustrine sediments, loess, and some glacial tills have base colors that appear as gleyed. On closer examination, their colors will normally not fit on the gley color pages. Information specific to each subregion follows:

Figure 12. The bluish color of the soil material on the left (from the upper portion of the soil profile) indicates reduced conditions. The dark color of the soil material on the right (from lower in the same soil profile) is the color of the parent material and not the result of saturation

Aleutian Alaska. This indicator is commonly found in tidal flats and estuaries, and upland depressions. It may be difficult to apply due to predominance of volcanic ash.

Interior Alaska. This indicator is commonly found along transition zones between fens and bogs and adjacent uplands, in groundwater discharge areas, and depressional areas within low floodplains. Saturation may be the result of a local riparian water table or water perched on restrictive layers, especially permafrost, within the soil.

Northern Alaska. This indicator is commonly found in depressions on floodplains, tidal flats, and foothills, and drainage channels on foothills. Saturation may be a result of local riparian water tables or water perched on permafrost.

Southcentral Alaska. This indicator is commonly found along transition zones between fens and bogs and adjacent uplands, groundwater discharge areas, and depressional areas within low floodplains. Saturation may be the result of a local riparian water table or water perched on restrictive layers within the soil.

Southeast Alaska. This indicator is commonly found along hill and mountain slopes. Saturation is usually the result of water perched on glacial till.

Western Alaska. This indicator is commonly found along transition zones between fens or bogs and the adjacent uplands, in groundwater discharge areas, and broad depressional areas within low floodplains and in deltaic areas.

Saturation may be the result of a local riparian water table or water perched on restrictive layers, including permafrost, within the soil.

Figure 13. The bluish band between 8 and 20 in. on the tape (20-50 cm) indicates the presence of reduced soil material. The underlying material below 20 in. reflects both the color of the parent material and soil weathering under aerobic conditions

Indicator A14: Alaska Redox

Technical Description: A mineral layer that has dominant hue of 5Y with chroma of 3 or less, or hue N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, or 5PB, with 10 percent or more distinct or prominent redox concentrations as pore linings with value and chroma of 4 or more. The layer starts within 12 in. (30 cm) of the soil surface.

User Notes: These soils have a layer within 12 in. (30 cm) of the mineral surface that meets the specified color requirements. These colors can be found on the 5Y page or the gleyed 1 or gleyed 2 pages of the Munsell soil color book (Gretag/Macbeth 2000). The layer must also contain at least 10 percent by volume redox concentrations (reddish-orange iron coatings) along pores (Figure 14). Redox concentrations are required to prove that the gleyed colors are not parent material colors.

Figure 14. The matrix color meets the requirements of a gleyed matrix. Reddish orange redox concentrations occur along pores and channels of living roots

In soils that have been reduced, one of the first areas where oxygen will be reintroduced is along pores and the channels of live roots. As oxidation occurs in these areas, characteristic reddish-orange redox concentrations (value and chroma of 4 or more) will be apparent along the pores and linings. These will stand out in contrast to the matrix color of the overall soil layer.

When applying this indicator, first note the dominant color(s) of the soil layer to see if it matches the colors indicated. Then break open pieces of the soil

and look for reddish-orange redox concentrations along pores and root linings (Figures 15 and 16). If these features are present, it indicates that the soil has been reduced during periods of wetness and, while in a drier state, has undergone oxidation.

Figure 15. Gleyed matrix colors and reddish-orange concentrations. Concentrations are along root channels

Figure 16. Gleyed matrix color and redox concentrations surrounding root channels

Aleutian Alaska. This indicator is commonly found in tidal flats and upland depressions. Identification may be difficult due to the predominance of volcanic ash.

Interior Alaska. This indicator is commonly found on most landforms. Saturation may be the result of fluctuating water tables in riparian zones or fluctuating water tables perched on slowly permeable materials, especially permafrost.

Northern Alaska. This indicator is commonly found along foothills and micro-high positions (patterned ground) on coastal plains. Saturation is usually the result of a fluctuating water table perched on seasonal frost or permafrost.

Southcentral Alaska. This indicator is commonly found in depressions on most landforms. Saturation may be the result of fluctuating water tables in riparian zones or fluctuating water tables perched on slowly permeable sediments.

Southeast Alaska. This indicator is commonly found near uplifted beaches and estuaries with loamy glaciofluvial parent materials. Saturation is usually the result of a fluctuating water table perched on slowly permeable sediments.

Western Alaska. This indicator is commonly found on most landforms. Saturation may be the result of fluctuating water tables in riparian zones or fluctuating water tables perched on slowly permeable materials.

Indicator A15: Alaska Gleyed Pores

Technical Description: A mineral layer that has 10 percent or more hue N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, or 5PB with value 4 or more in pores and along root channels starting within 12 in. (30 cm) of the soil surface. The matrix has a dominant hue of 5Y or redder.

User Notes: This indicator is intended to look for subtle evidence of active reduction in a soil. Due to the presence of organic carbon along root channels, visible evidence of reduction will first occur along the root channels (Figure 17). The evidence is thin coatings meeting the specified color (hue, value) requirements. These colors can be found on the gleyed 1 and gleyed 2 pages of the Munsell soil color book (Gretag/Macbeth 2000) (see Figure A2). Care must be taken to observe all of the color variations in the soil and not just the dominant soil color. Break pieces of soil open and closely look along the root channels. Many of these will be very thin or fine. A hand lens may be helpful.

In a soil layer that is turning anaerobic, reduced conditions will first occur where the soil microbes have an ample supply of organic carbon. Colder soils, as in Alaska, normally have low organic carbon, so microbes will congregate along the channels containing dead roots. It is along these channels that gley colors will first appear.

Figure 17. Reduction occurs first along root channels where organic carbon is concentrated. Note gleyed colors along root channels

Aleutian Alaska. This indicator is commonly found in tidal flats and upland depressions. It may be difficult to apply due to predominance of volcanic ash.

Interior Alaska. This indicator is commonly found in riparian areas and in depressions on most landforms where water tables perch on slowly permeable sediments, primarily permafrost. Where water tables fluctuate, redox concentrations may also be present.

Northern Alaska. This indicator is commonly found along floodplains subject to fluctuating water tables and/or ponding.

Southcentral Alaska. This indicator is commonly found in riparian areas and in depressions on most landforms where water tables perch on slowly permeable sediments. Where water tables fluctuate, redox concentrations may also be present.

Southeast Alaska. This indicator may occur in any saturated mineral soil and may be found across all landforms.

Western Alaska. This indicator is commonly found in riparian areas and in depressions on most landforms where water tables perch on slowly permeable material. Where water tables fluctuate, redox concentrations may also be present.

Hydric Soil Indicators for Problem Soils

The following indicators are not recognized for general application by the NTCHS and are intended for use only in problem wetland situations in Alaska that have evidence of wetland hydrology and hydrophytic vegetation, and are believed to meet the definition of a hydric soil, but lack recognized indicators of a hydric soil. To use these indicators, follow the procedure described in the section on Problematic Hydric Soils in Chapter 5.

Indicator TA4: Alaska Color Change

Technical Description: A mineral layer 4 in. (10 cm) or more thick starting within 12 in. (30 cm) of the soil surface that has a matrix value of 4 or more and chroma of 2 or less that becomes redder by one or more in hue and/or chroma when exposed to air within 30 minutes.

User Notes: The soil should be at or near saturation when examined. If the soil matrix is sufficiently reduced and has gley colors, reduced iron (Fe^{+2}) in the soil can begin to oxidize (Fe^{+3}) upon exposure to the air (Figures 18 and 19). Care must be taken to obtain an accurate color of the soil sample immediately upon excavation. The colors should be examined again after several minutes. Do not allow the sample to begin drying, as drying will also result in a color change. Care must be taken to observe the colors closely. As always, do not obtain colors

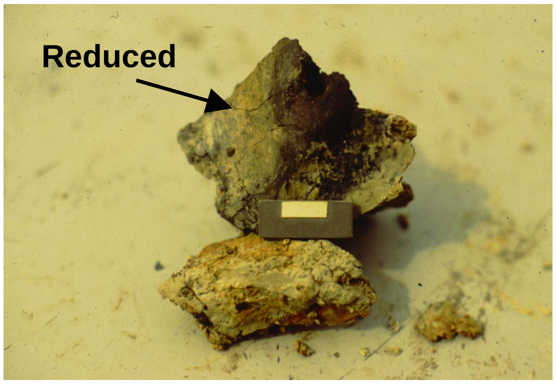

Figure 18. This soil exhibits colors associated with reducing conditions. (Scale is 1 cm)

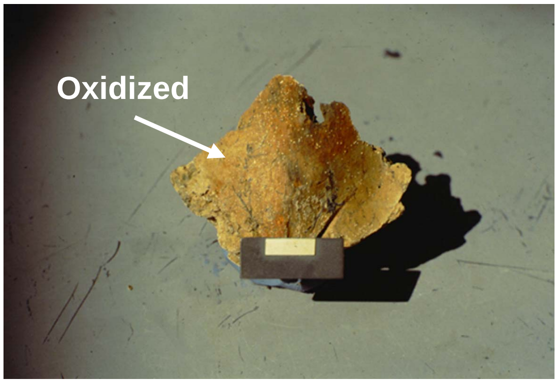

Figure 19. The same soil as in Figure 18 after exposure to the air and oxidation has occurred

while wearing sunglasses. Colors must be obtained in the field under natural light and not under artificial light. Look for the presence of other indicators.

Aleutian Alaska. Saturation is likely to be observed throughout the year.

Interior Alaska. Saturation is most likely during May and late July-September.

Northern Alaska. Saturation is most likely during June-August.

Southcentral Alaska. Saturation is most likely during April-May and September-October.

Southeast Alaska. Saturation is most likely during April-May and September-October.

Western Alaska. Saturation is most likely during May-September.

Indicator TA5: Alaska Alpine Swales

Technical Description: On concave landforms, the presence of a surface mineral layer 4 in. (10 cm) or more thick having hue of 10YR or yellower, value 2.5 or less, and chroma 2 or less. The dark surface layer is at least twice as thick as the surface mineral layer of soils on adjacent convex micro-positions.

User Notes: Soils with this indicator occur in concave positions in alpine and sub-alpine areas where moisture accumulates (Figure 20). Here the source of hydrology is meltwater from adjacent snowpack that persists well into the growing season. The landscape is usually a complex micro-topography of concave depressions and adjacent micro-highs. Soils should be examined in both landscape positions and compared. If both positions have a mineral surface of the same color, but the layer is at least twice as thick in the concave position, the soil in the concave position is considered hydric. Make sure that there is reasonable evidence of the hydrology source. This includes either direct observation of the melting snowpack or aerial imagery that shows snowpack at that location earlier in the growing season.

Aleutian Alaska. This indicator is not known to occur in this subregion.

Interior Alaska. Saturation is most likely to be observed during late May through early July. This is a common indicator in concave micro-positions on mountain slopes and plains where snow accumulates during the winter.

Northern Alaska. Saturation is most likely to be observed during late May through mid-July. This is a common indicator in concave micro-positions on mountain slopes and plains where snow accumulates during the winter.

Southcentral Alaska. Saturation is most likely to be observed during late May through early July. This is a common indicator in concave micro-positions on mountain slopes and plains where snow accumulates during the winter.

Southeast Alaska. This indicator is unknown in this subregion, but may exist in alpine areas.

Western Alaska. Saturation is most likely to be observed during late May through June. This is a common indicator in concave micro-positions on mountain slopes and plains where snow accumulates during the winter.

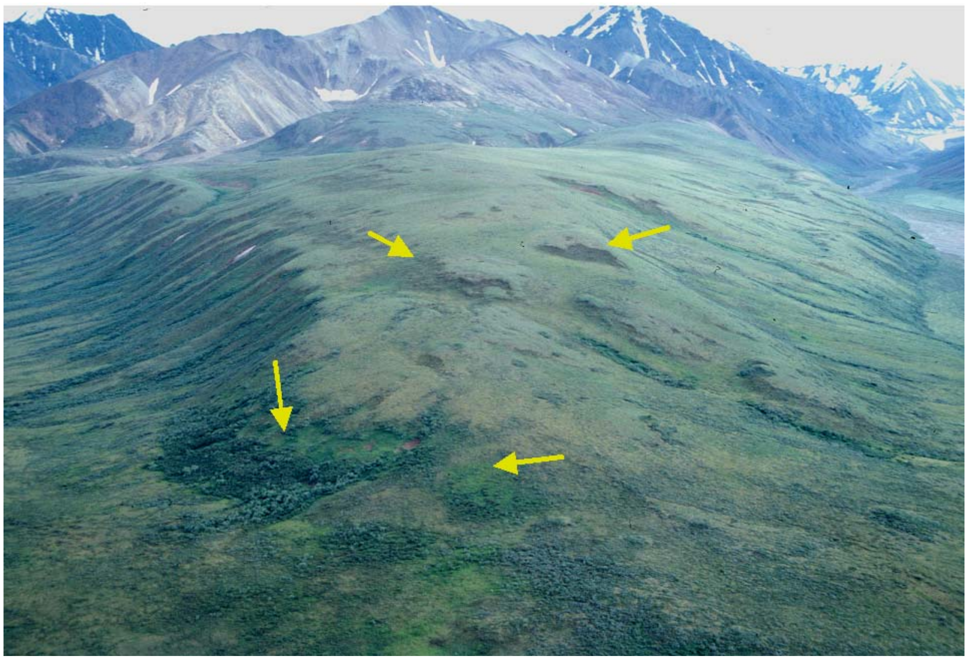

Figure 20. The arrows indicate concave micro-positions where water from snowmelt accumulates during late spring and early summer

Indicator: Alaska Redox with 2.5Y Hue

Technical Description: A mineral layer that has dominant hue of 2.5Y with chroma of 3 or less, with 10 percent or more distinct or prominent redox concentrations as pore linings with value and chroma of 4 or more. The layer starts within 12 in. (30 cm) of the soil surface.

User Notes: Hue of 2.5Y is excluded from the Alaska Redox indicator (A14). This is to avoid confusion with non-hydric soils that have hue of 2.5Y resulting from the color of the parent material and contain relict redox concentrations. Examples include soils formed in glacial tills and loess, especially if they were affected by seasonal frost or permafrost in the past. There are, however, areas where a hue of 2.5Y, chroma of 3 or less, and the presence of redox concentrations do indicate a hydric soil. For example, such soils are often found on the fringes of wetlands as they transition to upland areas.

Indicator: Alaska Gleyed without Hue 5Y or Redder Underlying Layer

Technical Description: A mineral layer with a gleyed matrix that occupies 50 percent or more of a layer that starts within 12 in. (30 cm) of the soil surface.

User Notes: Alaska Gleyed (A13) requires that the gleyed zone be underlain by similar soil material having a hue of 5Y or redder. This requirement is intended to eliminate confusion with non-hydric soils that have parent material colors similar to gleyed colors. There are areas, however, where continuously saturated conditions result in gleyed colors that are present to considerable depth in the soil profile. Such soils are continuously reduced and lack redox concentrations.

Use of Existing Soil Data

Soil surveys

Soil surveys are available for many areas of Alaska and can provide useful information regarding soil properties and soil moisture conditions for an area. Soil surveys in Alaska, however, vary considerably in the mapping scale and the amount of ground-truthing used to document the survey. A list of available soil surveys is located at http://www.ak.nrcs.usda.gov/technical/soils/soilsurveys.html. The most detailed surveys in the state are mapped at a scale of 1:24,000. At this scale, the smallest soil areas delineated are about 5 acres (2 ha) in size. Map units do not contain only one soil type, but may include several soils with similar properties and also soils that are quite dissimilar. Soils that are hydric are noted in the *Hydric Soils List* published as part of the survey report. The survey provides information as to whether an area contains predominantly hydric or non-hydric soils, but it does not provide site-specific information. The soil survey provides valuable information but it does not preclude the need for onsite examination. Several of the Alaska soil surveys are mapped at scales ranging from 1:63,360 to 1:250,000. The smallest areas delineated in these surveys range from 25-100 acres (10-40 ha) in size. Soil surveys provide helpful information but cannot be used alone to make a hydric soil determination.

The *Exploratory Soil Survey of Alaska* provides coverage of the entire state at a scale of 1:1,000,000. The minimum size of areas delineated ranges from thousands to tens of thousands of acres. The *Exploratory Soil Survey of Alaska* provides a good overview of the major soil types in the various regions of the state. It does not provide any information for hydric soil determinations.

Hydric soils lists

Hydric soils lists are developed for each of the “detailed” or 1:24,000-scale soil surveys in Alaska. Using criteria approved by the NTCHS, these lists rate each soil component as either hydric or non-hydric based on soil property data. If the soil is rated as hydric, information is provided regarding which hydric

criterion is met and on what landform the soil typically occurs. Hydric soil lists are very useful as general background information for onsite delineations. Remember, however, that 1:24,000-scale soil surveys only separate different soil areas that are at least 5 acres (2 ha) in size.

The hydric soil lists available for individual 1:24,000 scale soil surveys are known as *Local Hydric Soil Lists.* They are available as part of the published report for each survey area. Local Hydric Soils Lists have been compiled into a *National Hydric Soils List.* Use of the Local Hydric Soils Lists is preferred since they are more current and reflect local variations in soil properties.

4 Wetland Hydrology Indicators

Introduction

Wetland hydrology indicators are used in combination with indicators of hydric soil and hydrophytic vegetation to determine whether an area is a wetland under the Corps Manual. Soils and vegetation generally reflect a site's long-term to medium-term wetness history. The function of wetland hydrology indicators is to provide evidence that the site has a *continuing* wetland hydrologic regime and that hydric soils and hydrophytic vegetation are not relicts of a past hydrologic regime. Therefore, to the extent possible, wetland hydrology indicators are evidence of ongoing or recent flooding, ponding, or soil saturation or provide other evidence that hydric soils and hydrophytic vegetation reflect contemporary site conditions.

Hydrology indicators are the most ephemeral of wetland indicators. Those involving direct observation of surface water or saturated soils are often present only during the normal wet portion of the growing season and may be absent during the dry season or during drier-than-normal years. On the other hand, some indicators may be present on nonwetland sites during spring break-up, immediately after a heavy rain, or during a period of unusually high precipitation, river stages, runoff, or snowmelt. Normal seasonal variations in rainfall, temperature, and other climatic conditions should always be considered in interpreting hydrology indicators. Hydrology indicators help to confirm the presence of a continuing wetland hydrologic regime; however, the lack of an indicator is not evidence of the absence of wetland hydrology. Wetland situations that may lack hydrology indicators are discussed further in Chapter 5, "Difficult Wetland Situations in Alaska."

Areas that have hydrophytic vegetation and hydric soils generally also have wetland hydrology unless the hydrologic regime has changed due to natural events or human activities (National Research Council 1995). Therefore, when wetland hydrology indicators are absent from an area that has hydric soils and hydrophytic vegetation, additional effort may be needed to determine whether wetland hydrology is present. If the original site visit was made during the dry season or a drier-than-normal year, it may be necessary to revisit the site during the wet season or in a normal year and check again for hydrology indicators. Analytical techniques involving stream gauge data, runoff estimates, remote

sensing, scope-and-effect equations for ditches and subsurface drain lines, or groundwater modeling may also be useful (e.g., USDA Natural Resources Conservation Service 1997). On highly disturbed or problematic sites, direct hydrologic monitoring may be needed to determine whether wetland hydrology is present (U. S. Army Corps of Engineers 2005). See Chapter 5 for additional guidance.

Growing Season

Beginning and ending dates of the growing season are needed to evaluate certain wetland hydrology indicators, such as visual observations of flooding, ponding, or shallow water tables on potential wetland sites. In addition, growing season dates are needed in the event that recorded hydrologic data, such as stream gauge or water-table monitoring data, must be analyzed to determine whether wetland hydrology is present on highly disturbed or problematic sites. For convenience nationwide, the U.S. Army Corps of Engineers (2005) recommends a procedure for estimating growing season dates based on the median dates (i.e., 5 years in 10, or 50 percent probability) of 28 °F (-2.2 °C) air temperatures in spring and fall, based on long-term records gathered at National Weather Service meteorological stations and reported in WETS tables by the NRCS National Water and Climate Center (http://www.wcc.nrcs.usda.gov/climate/wetlands.html). However, this approach is often impractical in Alaska due to the scarcity of meteorological stations and differences in elevation, aspect, and other conditions between project sites and the locations of existing weather stations. An alternative approach to determine the growing season involves the direct observation of vegetation green-up, emergence, or growth as an indicator of biological activity, both above and below ground. During the growing season, soil microbial activity affects the ability of saturated soils to become anaerobic and reduced. Therefore, one or both of the following procedures may also be used in Alaska to determine growing season dates on a particular project site, subject to review and approval by the Corps of Engineers Alaska District.

1. Growing season dates for broad areas can be estimated by calculating the median date of the onset of vegetation green-up in spring and the median date of vegetation senescence in fall detected by remote sensing, as described by Markon (2001) (http://agdcftp1.wr.usgs.gov/pub/projects/lcc/ak_avhrr/pheno_ofr_final.pdf). Markon divides Alaska into 20 zones and, for each zone, reports the Julian date of initial green-up ("Minday") and senescence ("Lastday") for each year from 1991 to 1997. The median of these annual values may be used to estimate growing season beginning and ending dates when onsite observations are not available.

2. The growing season has begun in spring when plants comprising 50 percent or more of the total vegetation cover within the wetland or immediately surrounding areas are emerging (e.g., spring ephemerals), greening up, breaking bud, leafing out, or flowering. Observations should be made in the local plant community with the highest level of emergence of new growth. Supporting data, such as the species observed

and their coverage in the study area, should be reported in field notes or the delineation report.

Wetland Hydrology Indicators

In this chapter, wetland hydrology indicators are presented in four groups. Indicators in Group A are based on the direct observation of surface water or groundwater during a site visit. Group B consists of indirect evidence that the site was flooded or ponded recently, although the site may not be inundated currently. These indicators include water marks, drift deposits, sediment deposits, and similar features. Group C consists of indirect evidence that the soil was saturated recently. Some of these indicators, such as oxidized rhizospheres surrounding living roots or the presence of reduced iron in the profile, indicate that the soil has been saturated for an extended period. Group D consists of landscape characteristics and vegetation and soil features that indicate contemporary rather than historical wet conditions. Wetland hydrology indicators are intended as one-time observations of site conditions that provide support for wetland determinations in areas where hydric soils and hydrophytic vegetation are present.

Within each group, indicators are divided into two categories – *primary* and *secondary* – based on their estimated reliability in the region. One primary indicator from any group is sufficient to conclude that wetland hydrology is present; the area is a wetland if indicators of hydric soil and hydrophytic vegetation are also present. In the absence of a primary indicator, two or more secondary indicators from any group are required to conclude that wetland hydrology is present. Indicators of wetland hydrology include, but are not necessarily limited to, those listed in Table 5 and described on the following pages. Other evidence of wetland hydrology may also be used with appropriate documentation.

Group A – Observation of surface water or saturated soils

Indicator A1: Surface Water

Category: Primary

General Description: This indicator consists of the direct, visual observation of surface water (flooding or ponding) during a site visit (Figure 21).

Cautions and User Notes: Care must be used in applying this indicator because surface water may be present on a nonwetland site immediately after a rainfall event, during spring break-up, or during periods of unusually high precipitation, runoff, tides, or river stages. Surface water observed during the nongrowing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season. Surface water may be absent from a wetland during the normal dry season or during

periods of drought. Even under normal rainfall conditions, wetlands may have surface water present only one year in two (i.e., ≥50 percent probability). In addition, inundation may be infrequent, brief, or entirely lacking in groundwater-dominated wetland systems.

Table 5
List of Wetland Hydrology Indicators for Alaska

Indicator	Category: Primary	Category: Secondary
Group A – Observation of Surface Water or Saturated Soils		
A1 – Surface water	X	
A2 – High water table	X	
A3 – Saturation	X	
Group B – Evidence of Recent Inundation		
B1 – Water marks	X	
B2 – Sediment deposits	X	
B3 – Drift deposits	X	
B4 – Mat or crust of algae or marl	X	
B5 – Iron deposits	X	
B6 – Surface soil cracks	X	
B7 – Inundation visible on aerial imagery	X	
B8 – Sparsely vegetated concave surface	X	
B9 – Water-stained leaves		X
B10 – Drainage patterns		X
Group C – Evidence of Recent Soil Saturation		
C1 – Hydrogen sulfide odor	X	
C2 – Dry-season water table	X	
C3 – Oxidized rhizospheres along living roots		X
C4 – Presence of reduced iron		X
C5 – Salt deposits		X
Group D – Evidence from Other Site Conditions or Data		
D1 – Stunted or stressed plants		X
D2 – Geomorphic position		X
D3 – Shallow aquitard		X
D4 – Microtopographic relief		X
D5 – FAC-neutral test		X

Figure 21. Wetland with surface water present

Indicator A2: High Water Table

Category: Primary

General Description: This indicator consists of the direct, visual observation of the water table ≤12 in. (30 cm) of the surface in a soil pit, auger hole, or shallow monitoring well (Figure 22).

Cautions and User Notes: Sufficient time must be allowed for water to drain into a newly dug hole and to stabilize at the water-table level. The required time will vary depending upon soil texture. In some cases, the water table can be determined by examining the wall of the soil pit and identifying the upper level at which water is seeping into the pit. Care must be used in interpreting this indicator because water-table levels normally vary seasonally and are a function of both recent and long-term precipitation and seasonal frost conditions. Even under normal rainfall conditions, wetlands may have water tables within 12 in. of the surface only one year in two (i.e., ≥50 percent probability). For an accurate determination of the water-table level, the soil pit, auger hole, or well should not penetrate any restrictive soil layer capable of perching water near the surface.

Figure 22. High water table observed in a soil pit

Indicator A3: Saturation

Category: Primary

General Description: Visual observation of saturated or near-saturated soil conditions as indicated by water glistening on the surfaces and broken interior faces of soil samples removed from the pit or auger hole ≤12 in. (30 cm) of the soil surface (Figure 23). This indicator must be associated with an existing water table located immediately below the saturated zone.

Cautions and User Notes: Glistening is evidence of saturated or near-saturated conditions, indicating that the soil sample was taken either below the water table or within the capillary fringe above the water table. Recent rainfall events and

the proximity of the water table at the time of sampling should be considered in applying and interpreting this indicator. Water observed in soil cracks or on ped faces does not meet this indicator unless ped interiors are also saturated.

Figure 23. Water glistens on the surface of a saturated soil sample

Group B – Evidence of recent inundation

Indicator B1: Water Marks

Category: Primary

General Description: Water marks are discolorations or stains on bark of woody vegetation, rocks, bridge pillars, buildings, fences, or other fixed objects as a result of inundation (Figure 24).

Figure 24. Water marks on a boulder

Cautions and User Notes: When several water marks are present, the highest reflects the maximum extent of inundation. Water marks indicate a water-level elevation and can be extrapolated from nearby objects across lower elevation areas. Use caution with water marks that may have been caused by extreme or abnormal flooding events or by brief, temporary flooding during the spring break-up period.

Indicator B2: Sediment Deposits

Category: Primary

General Description: Sediment deposits are thin layers or coatings of fine mineral material (e.g., silt or clay) or organic matter, sometimes mixed with other plant detritus, remaining on plants and other objects after inundation and dewatering (Figure 25).

Cautions and User Notes: Sediment deposits may remain for a considerable period before being removed by precipitation or subsequent inundation. Sediment deposits on vegetation or other objects indicate the minimum inundation level. This level can be extrapolated across lower elevation areas. This indicator does not include thick accumulations of sand or gravel in or adjacent to fluvial channels that may reflect historic flow conditions or recent extreme events. Use caution with sediment that may be left following spring snowmelt when silt and other material trapped in the snowpack is deposited directly on the ground surface.

Figure 25. Deposits of gray sediment on sedges in a tidal channel

Indicator B3: Drift Deposits

Category: Primary

General Description: Drift deposits consist of rafted debris that has been deposited on the ground surface or entangled in vegetation or other fixed objects. Debris consists of remnants of vegetation (e.g., branches, stems, and leaves), man-made litter, or other waterborne materials. Drift material may be deposited at or near the high-water line in ponded or flooded areas, piled against the upstream side of trees, rocks, and other fixed objects, or widely distributed within the inundated and dewatered area (Figure 26).

Cautions and User Notes: Deposits of drift material are often found adjacent to streams or other sources of flowing water in wetlands. They also occur in tidal marshes, along lakeshores, and in other ponded areas. Drift lines indicate the minimum water level attained during a flooding event; the maximum level of inundation is generally higher than that indicated by a drift line. The elevation of a drift line can be extrapolated across lower elevation areas. Use caution with drift lines that may have been caused by extreme, infrequent, or very brief flooding events.

Figure 26. Drift deposit of leaves in a seasonally ponded wetland

Indicator B4: Mat or Crust of Algae or Marl

Category: Primary

General Description: This indicator consists of a mat or dried crust of algae or marl, perhaps mixed with other detritus, left on or near the soil surface after dewatering.

Cautions and User Notes: Algae or marl may be attached to low vegetation or other fixed objects, or may cover the soil surface. Dried surface crusts may crack and curl at plate margins (Figure 27). Algal crusts are usually seen in seasonally

ponded areas, lake fringes, and low-gradient stream margins. They reflect prolonged wet conditions sufficient for algal growth and development. Marl deposits consist mainly of calcium carbonate precipitated from standing water through the action of algae or diatoms. Marl appears as a tan or whitish coating on the soil surface after dewatering (Figure 28). Algal mats or crusts are not common but may be found throughout Alaska. Marl deposits are found mainly in northern Alaska.

Figure 27. Dried algal crust on the soil surface

Figure 28. Marl deposit (tan-colored areas) and iron sheen in a subarctic fen

Indicator B5: Iron Deposits

Category: Primary

General Description: This indicator consists of a thin orange or yellow crust or gel of oxidized iron on the soil surface or on objects near the surface.

Cautions and User Notes: Iron deposits form in areas where reduced iron discharges with groundwater and oxidizes upon exposure to air. The oxidized

iron forms a film or sheen on standing water (Figure 29) and an orange or yellow deposit (Figure 30) on the ground surface after dewatering.

Figure 29. Iron sheen on the water surface may be deposited as an orange or yellow crust after dewatering

Figure 30. Iron deposit (orange area) in a ponded depression

Indicator B6: Surface Soil Cracks

Category: Primary

General Description: Surface soil cracks consist of shallow cracks that form when mineral or organic soil material dries and shrinks, often creating a network of cracks or small polygons (Figures 31 and 32).

Cautions and User Notes: This indicator is usually seen in fine sediments in seasonally ponded depressions, lake fringes, or floodplains. It should not be confused with patterned ground features caused by frost action in interior, northern, and western Alaska.

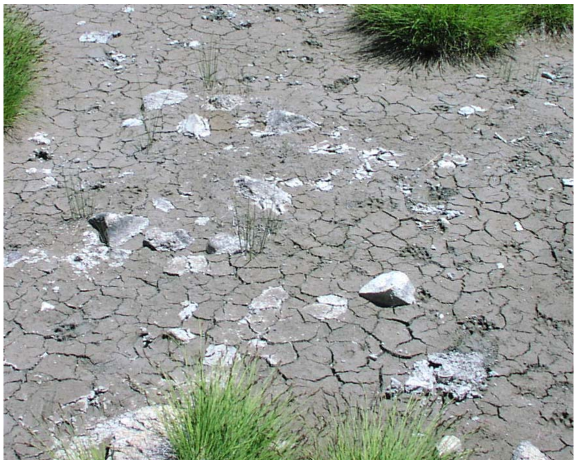

Figure 31. Surface cracks in a mineral soil in a seasonally ponded wetland

Figure 32. Surface cracks in an organic soil

Indicator B7: Inundation Visible on Aerial Imagery

Category: Primary

General Description: One or more recent aerial photographs or satellite images show the site to be inundated.

Cautions and User Notes: The most recent available aerial imagery should be used to evaluate this indicator. Older imagery may be useful if there has been no known hydrologic change (e.g., change in river course, tectonic activity, or human alteration) since the date of the photograph. Care must be used in applying this indicator because surface water may be present on a nonwetland

site immediately after a heavy rain, during spring break-up, or during periods of unusually high precipitation, runoff, tides, or river stages. WETS tables provided by the NRCS National Water and Climate Center (http://www.wcc.nrcs.usda.gov/climate/wetlands.html) may be used to determine whether rainfall prior to the photo date was normal, greater than normal, or less than normal based on long-term records at National Weather Service stations. Even under normal rainfall conditions, wetlands may have surface water present only one year in two (i.e., ≥50 percent probability). Surface water observed during the nongrowing season may be an acceptable indicator if experience and professional judgment suggest that wet conditions normally extend into the growing season. Surface water may be absent from a wetland during the normal dry season or during periods of drought. Normal seasonal and annual variations in water levels should be considered in interpreting this indicator.

Indicator B8: Sparsely Vegetated Concave Surface

Category: Primary

General Description: This indicator is found on concave land surfaces (depressions and swales) and consists of areas that are either unvegetated or sparsely vegetated (<5 percent cover) due to long-duration ponding during the growing season (Figure 33).

Cautions and User Notes: Sparsely vegetated concave surfaces should contrast with vegetated slopes and convex surfaces in the same area. Use caution to avoid confusing this indicator with small bare areas resulting from patterned-ground processes in northern, interior, and western Alaska.

Figure 33. A sparsely vegetated, seasonally ponded depression

Indicator B9: Water-Stained Leaves

Category: Secondary

General Description: Water-stained leaves are fallen leaves or needles that have turned dark grayish or blackish in color due to inundation for long periods.

Cautions and User Notes: Water-stained leaves are generally found in depressions, flats, or along stream margins in forested or shrub-dominated wetlands. Water-stained leaves maintain their blackish or dark grayish colors when dry. They should contrast strongly with fallen leaves in nearby upland landscape positions.

Indicator B10: Drainage Patterns

Category: Secondary

General Description: This indicator consists of evidence that water flowed across the ground surface, such as flow patterns eroded into the soil, low vegetation bent over in the direction of flow, absence of leaf litter or small woody debris due to flowing water, and scouring of soil from around plant roots.

Cautions and User Notes: Drainage patterns are usually seen in areas where water flows broadly over the surface and is not confined to a channel, such as in areas adjacent to streams (Figure 34), slope wetlands, vegetated swales, and tidal flats. Use caution in areas affected by extreme or abnormal flooding events or by brief, temporary flooding during the spring break-up period.

Figure 34. Vegetation bent over in the direction of water flow across a stream terrace

Group C – Evidence of recent soil saturation

Indicator C1: Hydrogen Sulfide Odor

Category: Primary

General Description: A hydrogen sulfide (rotten egg) odor within 12 in. (30 cm) of the soil surface.

Cautions and User Notes: Hydrogen sulfide is a gas produced by soil microbes in response to prolonged soil saturation. For hydrogen sulfide to be detectable, the soil must be saturated at the time of sampling and must have been saturated long enough to become highly reduced. These soils are often permanently saturated and anoxic at or near the surface. To apply this indicator, dig a pit no deeper than 12 in. to avoid release of hydrogen sulfide from deeper in the profile.

Indicator C2: Dry-Season Water Table

Category: Primary

General Description: This indicator consists of the visual observation of the water table between 12 and 24 in. (30 and 60 cm) of the surface for mineral soils, or 12 and 40 in. (30 and 100 cm) for organic soils, during the normal dry season or during a drier-than-normal year.

Cautions and User Notes: Due to normal seasonal fluctuations, water tables in wetlands often drop below 12 in. during the dry season. For sites with mineral soils in Alaska, an observed water table within 24 in. during the dry season, or during an unusually dry year, is strong evidence for a water table within 12 in. during the normal wet portion of the growing season. For organic soils, a dry-season water table within 40 in. indicates a normal wet-season water table within 12 in. A soil auger may be needed to evaluate this indicator. Sufficient time must be allowed for water to drain into a newly dug hole and to stabilize at the water-table level. The required time will vary depending upon soil texture. In some cases, the water table can be determined by examining the wall of the soil pit and identifying the upper level at which water is seeping into the pit. For an accurate determination of the water-table level, the soil pit, auger hole, or well should not penetrate any restrictive soil layer capable of perching water near the surface. See Chapter 5 (section on Wetlands that Periodically Lack Indicators of Wetland Hydrology) for determining dry-season dates and for procedures to evaluate normal rainfall and snowpack.

Indicator C3: Oxidized Rhizospheres Along Living Roots

Category: Secondary

General Description: This indicator consists of iron oxide coatings or plaques on the surfaces of living roots and/or iron oxide coatings or linings on soil pores immediately surrounding living roots within 12 in. (30 cm) of the soil surface (Figure 35).

Cautions and User Notes: Iron oxide coatings are the result of oxygen leakage from living roots into the surrounding anoxic soil, causing oxidation of ferrous iron present in the soil solution. They are evidence of saturated and reduced soil conditions during the plant's lifetime. Iron concentrations or plaques may form on the immediate root surface or may coat the soil pore adjacent to the root. In either case, the oxidized iron must be associated with living roots to indicate contemporary wet conditions. Care must be taken to distinguish iron oxide coatings from organic matter associated with plant roots. Viewing with a hand lens may help distinguish mineral from organic material. Iron coatings sometimes show concentric layers in cross section and may transfer iron stains to the fingers when rubbed. This indicator is assigned a secondary rating in Alaska because of the potential for relict oxidized rhizospheres, still associated with living roots, in areas where the permafrost layer has thawed due to recent climate change or fires that have destroyed the insulating moss layer. Thawing of the permafrost can cause a drop in water tables and the loss of wetland hydrology. However, oxidized rhizospheres may persist until the death of the plants that produced them.

Figure 35. Iron oxide plaque (orange coating) on a living root. Iron oxide also coats the channel or pore from which the root was removed

Indicator C4: Presence of Reduced Iron

Category: Secondary

General Description: Presence of reduced (ferrous) iron in the upper 12 in. (30 cm) of the soil profile, as indicated by a positive reaction to a ferrous iron test or by the presence of a soil that changes color upon exposure to the air.

Cautions and User Notes: Iron reduction occurs as a result of microbial activity in soils that have been saturated long enough to become anoxic and chemically reduced. Ferrous iron is converted back to oxidized forms when the saturation period ends. Therefore, the presence of ferrous iron usually indicates that the soil is saturated at the time of sampling and has been saturated for an extended period of time (Figure 36). The presence of ferrous iron can be verified with alpha, alpha-dipyridyl dye (see Chapter 5) or by observing a soil that changes color upon exposure to oxygen. When using alpha, alpha-dipyridyl dye, soil samples should be tested immediately after opening the soil pit because ferrous iron may oxidize soon after the sample is exposed to the air. To evaluate a color change, first determine soil color on a freshly broken sample from the newly opened pit, then repeat the color measurement on the same sample after a few minutes.

Figure 36. When alpha, alpha-dipyridyl dye is applied to a soil containing reduced iron, a positive reaction is indicated by a pink or red coloration to the treated area

Indicator C5: Salt Deposits

Category: Secondary

General Description: Salt deposits are whitish or brownish deposits of salts that accumulate on the ground surface through the capillary action of groundwater (Figure 37).

Cautions and User Notes: Salt deposits occur in areas of seasonal moisture deficit where evaporation brings capillary water to the surface. They often occur on floodplain terraces after surface water has receded and the water table is near

the surface. Salt deposits are not known to occur in southeast Alaska. Use caution in disturbed areas where salt water or brine has been deposited on the surface through runoff from surface sources, such as gravel piles.

Figure 37. Salt deposits on the soil surface (25-cent coin for scale)

Group D – Evidence from other site conditions or data

Indicator D1: Stunted or Stressed Plants

Category: Secondary

General Description: This indicator is present if individuals of the same species growing in the potential wetland are clearly of smaller stature, less vigorous, or stressed compared with individuals growing in nearby nonwetland situations (Figure 38).

Figure 38. Black spruce in the wetland (foreground) are stressed and stunted compared with spruce in the adjacent upland (background)

Cautions and User Notes: Some plant species in Alaska grow in both wetlands and uplands but may exhibit obvious stunting or stress in wet situations (e.g., *Picea mariana*). Use caution in areas where stunting of plants on upland sites

may be caused by low soil fertility, excessively drained soils, cold temperatures, shallow permafrost, or other factors. For this indicator to be present, a majority of individuals in the stand must be stunted or stressed.

Indicator D2: Geomorphic Position

Category: Secondary

General Description: This indicator is present if the area in question is located in a localized depression or other concave surface, within a minor drainage or on an active floodplain, at the toe of a slope, on the low-elevation fringe of a pond or other water body (Figure 39), or in an area where groundwater discharges.

Cautions and User Notes: Excess water from precipitation and snowmelt naturally accumulates in certain geomorphic positions in the landscape, particularly in low-lying areas such as depressions, drainages, toe slopes, and fringes of water bodies. With the exceptions noted below, these areas in Alaska often exhibit wetland hydrology.

Exceptions: This indicator does not include depressional areas in karst topography in southeast Alaska, which often drain freely. Furthermore, there are areas throughout Alaska where concave topography exists on rapidly permeable soils (e.g., outwash plains with sand and gravel substrates) that do not have wetland hydrology unless the water table is near the surface.

Figure 39. Certain geomorphic positions, such as lake fringes, are evidence of wetland hydrology

Indicator D3: Shallow Aquitard

Category: Secondary

General Description: This indicator consists of the presence of an aquitard within 24 in. (60 cm) of the soil surface that is potentially capable of perching water within 12 in. (30 cm) of the surface.

Cautions and User Notes: An aquitard is a relatively impermeable soil layer or bedrock that slows the downward percolation of water and can produce a perched water table. Potential aquitards include permafrost, dense glacial till, lacustrine deposits, iron-cemented layers, and clay layers. Soil layers that are only seasonally frozen do not qualify as aquitards unless they are observed to perch water for long periods during the growing season in most years.

Indicator D4: Microtopographic Relief

Category: Secondary

General Description: This indicator consists of the presence of microtopographic features, such as hummocks, flarks and strangs, tussocks, frost circles, or pedestals, with microhighs less than 36 in. (90 cm) above the base soil level.

Cautions and User Notes: These features are the result of vegetative and geomorphic processes in wetlands and produce the characteristic microtopographic diversity in some wetland systems (Figures 40 and 41). Microtopographic lows are either inundated or have shallow water tables for long periods each year. Microtopographic highs may or may not have wetland hydrology, but usually are small, narrow, or fragmented, often occupying less than half of the surface area. If indicators of hydrophytic vegetation or hydric soil are absent from microhighs, see the procedure for wetland/non-wetland mosaics in Chapter 5. This indicator does not include features caused by trampling, such as caribou trails.

Figure 40. Aerial view of flarks (microlows and pools dominated by sedges) and strangs (low ridges) in a wetland complex near Anchorage

Figure 41. Frost circles in Denali National Park. Light-colored areas are microhighs dominated by lichens. Microlows are dominated by dwarf birch (*Betula nana*) and sedges

Indicator D5: FAC-neutral test

Category: Secondary

General Description: The plant community passes the FAC-neutral test.

Cautions and User Notes: The FAC-neutral test is performed by compiling a list of dominant plant species across all strata in the community, and dropping from the list any species with a Facultative (FAC) indicator status. The FAC-neutral test is met if >50 percent of the remaining dominant species are rated FACW and/or OBL. This indicator may be used in communities that contain no FAC dominants. If there are an equal number of dominants that are OBL and FACW versus FACU and UPL, nondominant species should be considered. Dominant species in each stratum are identified by using the 50/20 rule (see Appendix C for suggested strata and the procedure for the 50/20 rule).

5 Difficult Wetland Situations in Alaska

Introduction

Some wetlands can be difficult to identify because wetland indicators may be missing at times due to natural processes or recent disturbances. This chapter provides guidance for making wetland determinations in difficult-to-identify wetland situations in Alaska. It includes regional examples of Problem Area wetlands and Atypical Situations as defined in the Corps Manual, as well as other situations that can make wetland delineation more challenging. Problem Area wetlands are defined as naturally occurring wetland types that periodically lack indicators of hydrophytic vegetation, hydric soil, or wetland hydrology due to normal seasonal or annual variability. In addition, some Problem Area wetlands may permanently lack certain indicators due to the nature of the soils or plant species on the site. Atypical Situations are defined as wetlands in which vegetation, soil, or hydrology indicators are absent due to recent human activities or natural events. In addition, this chapter addresses certain procedural problems (e.g., wetland/non-wetland mosaics) that can make wetland determinations in Alaska difficult or confusing. The chapter is organized into the following sections:

- Wetlands that lack indicators of hydrophytic vegetation.
- Problematic hydric soils.
- Wetlands that periodically lack indicators of wetland hydrology.
- Wetland/non-wetland mosaics.

This list is not intended to be exhaustive and other problematic wetland situations may exist in the State. See the Corps Manual for general guidance. In general, *wetland determinations on difficult or problematic sites must be based on the best information available to the field inspector, interpreted in light of his or her personal experience and knowledge of the ecology of wetlands in the region*.

Wetlands That Lack Indicators of Hydrophytic Vegetation

Description of the problem

Some wetlands in Alaska are difficult to identify because their plant communities contain a prevalence of FACU species, causing them to fail the prevalence index. Some of these communities may exhibit other indicators of hydrophytic vegetation (e.g., wetland cryptogams, morphological adaptations), but others may not. Examples of FACU species that may dominate in certain wetland situations include paper birch, white spruce, Sitka spruce, devil's club (*Oplopanax horridus*), and field horsetail. Sometimes these FACU species occur on hummocks, slightly elevated above the general soil level, where they can avoid the physiological effects of prolonged saturation in the root zone. Other FACU and UPL herbs and shrubs may co-occur with these species on hummocks. At other times, they may be more generally distributed across the wet area. Wetlands along creeks in the Anchorage basin, for example, are often dominated by paper birch growing on hummocks with field horsetail growing more widely in the understory.

Procedure

Wetlands dominated by FACU species can be identified through a combination of observations made in the field and/or supplemental information from the scientific literature. This procedure should be applied only where indicators of hydric soil and wetland hydrology are present but no indicators of hydrophytic vegetation are evident. The following procedure is recommended:

1. Verify that at least one indicator of hydric soil and one primary or two secondary indicators of wetland hydrology are present. If indicators of either hydric soil or wetland hydrology are absent, the area is likely non-wetland. If indicators are present, proceed to step 2.

2. Use one or more of the following approaches to determine whether the site is a wetland:

   a. *Direct hydrologic observations.* Verify that the plant community occurs in an area subject to prolonged inundation or soil saturation during the growing season. This can be done by visiting the site at 2- to 3-day intervals during the portion of the growing season when surface water is most likely to be present or water tables are normally high. Hydrophytic vegetation is considered to be present, and the site is a wetland, if surface water is present and/or the soil is saturated within 12 in. of the surface for ≥14 consecutive days during the growing season. If necessary, microtopographic highs and lows should be evaluated separately. The normality of the previous winter's snowpack and current year's rainfall should be considered in

interpreting field results, as well as the likelihood that wet conditions will occur on the site at least every other year (see the section titled "Wetlands that Periodically Lack Indicators of Wetland Hydrology" in this chapter).

b. *Reference sites.* If indicators of hydric soil and wetland hydrology are present on a site with FACU-dominated vegetation, the site may be considered to be a wetland if the landscape setting, topography, soils, and vegetation are substantially the same as those on nearby wetland reference areas. Wetland reference areas should have documented hydrology established through long-term monitoring or by repeated application of the procedure described in item 2*a* above. Reference sites should be minimally disturbed and provide long-term access. Soils, vegetation, and hydrologic conditions should be thoroughly documented and the data kept on file in the District or field office.

c. *Supporting Documentation.* Published and unpublished scientific literature may be used to support a decision to treat specific FACU species as hydrophytes or certain plant communities as hydrophytic. Preferably, this documentation should discuss the species' natural distribution along the moisture gradient, its capabilities and adaptations for life in wetlands, wetland types in which it is typically found, or other wetland species with which it is commonly associated.

Problematic Hydric Soils

Introduction

Some soils that meet the hydric soil definition may not exhibit any of the indicators presented in Chapter 3. These problematic hydric soils exist for a number of reasons and require additional information, such as landscape position, presence or absence of restrictive soil layers, or information about hydrology, to identify properly. This section describes several soil situations in Alaska that are considered hydric if additional requirements are met. In some cases, the lack of hydric soil indicators is due to conditions that inhibit the development of redoximorphic features despite prolonged soil saturation and anoxia. In addition, recently developed wetlands may lack hydric soil indicators because insufficient time has passed for their development. Examples of problematic hydric soils in Alaska include, but are not limited to, the following.

Soils with low organic-carbon content. Soil microbes require the presence of sufficient organic carbon in a soil in order to thrive. If there is little or no organic carbon present in a saturated soil, microbial activity will often be insufficient to produce noticeable hydric soil indicators. This is especially true in young or recently formed soils. Examples include recently formed sandy and gravelly soils (Figure 42).

Soils with low weatherable-iron content. A soil may contain little or no weatherable iron-bearing material due to the mineralogy of the parent material in which it formed. Gley colors, iron depletions, redox concentrations, and reaction to alpha, alpha-dipyridyl dye all require the presence of weatherable iron. If sufficient weatherable iron-bearing material is lacking in a saturated soil, these hydric soil indicators will be very weak or absent. Examples include soils formed in some types of volcanic ash or from diorite parent materials.

Soils with pH greater than 7.2. Formation of redox concentrations and depletions require that soluble iron be present in the soil. Iron readily enters into solution in acidic soils. In soils with higher pH, less iron enters into solution. As a result, redox concentrations may be very faint and difficult to observe in a soil with higher pH (Figure 43). Examples include soils in the Copper River Basin that have high pH due to the influence of parent material.

Figure 42. Low organic-matter content and coarse gravelly materials can make identification of hydric soil indicators difficult

Figure 43. Gley colors and redox concentrations are relatively faint due to the high pH of the soil materials in this profile from the Copper River Basin

Recently developed wetlands. Recently developed wetlands include mitigation sites, wetland management areas (e.g., for waterfowl), other wetlands intentionally or unintentionally produced by human activities, and naturally occurring wetlands that have not been in place long enough to develop hydric soil indicators. These soils should be considered hydric if they are ponded, flooded, or saturated for ≥14 consecutive days during the growing season in most years based on actual data and not on estimated soil properties.

Procedure

A soil that meets the definition of a hydric soil but does not exhibit any of the hydric soil indicators recognized by the NTCHS (see Chapter 3) can be identified by the following recommended procedure. This procedure should be used only where indicators of hydrophytic vegetation and wetland hydrology are present but indicators of hydric soil are not evident. Use caution in areas where vegetation and hydrology are also problematic.

1. Verify that one or more indicators of hydrophytic vegetation are present. If so, proceed to step 2.

2. Verify that at least one primary indicator of wetland hydrology is present. In this procedure, secondary indicators are not considered to be sufficient evidence of wetland hydrology. If at least one primary indicator of wetland hydrology is present, proceed to step 3.

3. Thoroughly describe and document the soil profile and landscape setting. Verify that the area is in a landscape position that is likely to collect or concentrate water. Appropriate settings include the following; if the landscape setting is appropriate, proceed to step 4.

    a. Concave surface (e.g., depression or swale).
    b. Active floodplain or low terrace.
    c. Level or nearly level area (e.g., 0- to 3-percent slope).
    d. Toe slope or an area of convergent slopes.
    e. Fringe of another wetland or water body.
    f. Area with a restrictive soil layer or aquitard within 24 in. (60 cm) of the surface.
    g. Other (explain in field notes why this area is likely to be inundated or saturated for long periods).

4. Use one or more of the following approaches to determine whether the soil is hydric. If needed, the remarks section of the data form or separate field notes may be used to explain why it is believed that the soil lacks any of the NTCHS hydric soil indicators described in Chapter 3 and why it is believed that the soil meets the definition of a hydric soil.

    a. Determine whether one or more of the following indicators of problematic hydric soils is present (see Chapter 3 for descriptions of these indicators). If one or more indicators is present, then the soil is hydric.

        i. Alaska Color Change (TA4).
        ii. Alaska Alpine Swales (TA5).
        iii. Alaska Redox with 2.5Y Hue.
        iv. Alaska Gleyed without Hue 5Y or Redder Underlying Layer.

b. Determine whether one or more of the following problematic hydric soil situations is present. If so, the soil is hydric.

   i. Soil has low organic matter content (e.g., recently deposited sandy or gravelly soils).
   ii. Soil has low weatherable iron content.
   iii. Soil has high pH ($\geq$7.2).
   iv. Area is a recently developed wetland.

c. If the soil is saturated at the time of sampling, alpha, alpha-dipyridyl dye can be used in the following procedure to determine if reduced (ferrous) iron is present. If ferrous iron is present as described below, then the soil is hydric.

   Alpha, alpha-dipyridyl is a dye that reacts with reduced iron. In some cases, it can be used to provide evidence that a soil is hydric when it lacks other hydric soil indicators. The soil is likely to be hydric if application of alpha, alpha-dipyridyl dye to mineral soil material in at least 60 percent of a layer at least 4 in. (10 cm) thick within a depth of 12 in. (30 cm) from the soil surface results in a positive reaction within 30 seconds evidenced by a pink or red coloration to the dye during the growing season.

   Using a dropper, apply a small amount of dye to a freshly broken ped face to avoid any chance of a false positive test due to iron contamination from digging tools. Look closely at the treated soil for evidence of color change. If in doubt, apply the dye to a sample of known upland soil and compare the reaction to the sample of interest. A positive reaction will not be present in soils that lack iron. The lack of a positive reaction to the dye does not preclude the presence of a hydric soil. Specific information about the use of alpha, alpha-dipyridyl can be found in NRCS Hydric Soils Technical Note 8 (http://soils.usda.gov/use/hydric/ntchs/tech notes/note8.html).

d. Using gauge data, water-table monitoring data, or repeated direct hydrologic observations, determine whether the soil is ponded or flooded, or the water table is $\leq$12 in. (30 cm) from the surface, for $\geq$14 consecutive days during the growing season in most years ($\geq$50 percent probability). If so, then the soil is hydric.

Wetlands that Periodically Lack Indicators of Wetland Hydrology

Description of the problem

Wetlands are areas that are flooded or ponded, or have soils that are saturated with water, for long periods in most years. Saturation in the root zone leads to anaerobic conditions and the unique vegetation and soil characteristics that are used to identify wetlands in the field. If the site is visited during a time when it is inundated or the water table is near the surface, then the wetland hydrology determination is straightforward. However, many wetlands dry out for part of the year, particularly around their margins where they grade into the surrounding uplands. Furthermore, some wetlands may inundate or saturate only briefly, or not at all, in some years, although they exhibit obvious wetland hydrology during most years in a long-term record.

Wetland hydrology determinations are based on indicators, many of which were designed to be used during drier periods when the direct observation of surface water or a shallow water table is not possible. However, some wetlands may lack any of the listed hydrology indicators, particularly during the normal dry season or in a drier-than-normal year. The evaluation of wetland hydrology requires special care on any site where indicators of hydrophytic vegetation and hydric soil are present but hydrology indicators appear to be absent. This evaluation should consider the timing of the site visit in relation to normal seasonal and annual hydrologic variability, and whether antecedent snowpack and rainfall conditions have been normal.

Procedure

The following recommended procedure may be used whenever wetland hydrology indicators appear to be absent on a site containing hydrophytic vegetation and hydric soil. Note that some of these approaches require meteorological data that may not be available for some sites due to the distance between weather stations in Alaska, the relatively low elevation of most stations, and the effects of topography on local weather patterns.

1. Verify that indicators of hydrophytic vegetation and hydric soil are present, and that the site is in a geomorphic position where wetlands often occur (e.g., depression or swale, level or nearly level area, toe slope, convergent slopes, low terrace, active floodplain or backwater, the fringe of another wetland or water body, or on a soil with a shallow restrictive layer). If these conditions are present, proceed to step 2.

2. Use one or more of the following approaches to determine whether the site is a wetland:

a. *Site visits during the dry season*. Determine whether the site visit occurred during the normal annual "dry season." The dry season, as used in this supplement, is the period of the year when water tables normally fall to low levels in response to decreased precipitation and/or increased evapotranspiration, usually during the summer. It also includes the beginning of the recovery period in late summer. The following are approximate average dates of the dry season for various areas within the state (within areas, actual dates vary by locale and year):

Aleutian Alaska – no significant dry season
Southeast Alaska – no significant dry season
Southcentral Alaska (Anchorage basin) – mid-May through late July
Interior Alaska – mid-May through late July
Western Alaska – mid-May through late July
Northern Alaska – no significant dry season due to the extended period of thaw

Another source of information that can be used to determine dry seasons is the Web-Based Water-Budget Interactive Modeling Program (WebWIMP) (http://climate.geog.udel.edu/~wimp/). WebWIMP will calculate the approximate dates of wet and dry seasons for any terrestrial location based on average monthly precipitation and estimated evapotranspiration. In general, the dry season in a typical year is indicated when evapotranspiration exceeds precipitation (negative values of DIFF), resulting in drawdown of soil moisture (negative values of DST) and/or a moisture deficit (DEF). Again, actual dates for the dry season vary by locale and year.

In many wetlands, direct observation of flooding, ponding, or a shallow water table would be unexpected during the dry season. Wetland hydrology indicators, if present, would most likely be limited to indirect evidence, such as water marks, drift deposits, or surface cracks. In some situations, hydrology indicators may be absent. If the site visit occurred during the dry season on a site that contains hydric soils and hydrophytic vegetation and no evidence of hydrologic manipulation, consider the site to be a wetland. If necessary, confirm the wetland determination by revisiting the site during the normal wet season and checking again for hydrology indicators.

b. *Years with unusually low winter snowpack.* Determine whether the site visit occurred following a winter with unusually low snowpack. In portions of Alaska where the snowpack persists throughout the winter, water availability in spring and early summer depends on winter water storage in the form of snow and ice. Therefore, springtime water availability in a given year can be evaluated by comparing the liquid equivalent of snowfall

over the previous winter (e.g., September through April) against 30-year averages calculated for National Weather Service meteorological stations (http://lwf.ncdc.noaa.gov/oa/ncdc.html) or for NRCS SNOTEL sites (http://www.wcc.nrcs.usda.gov/factpub/ads/ads_ak.html). This procedure may not be reliable in areas where the snowpack is not persistent and water is released intermittently throughout the winter.

In years when winter snowpack is appreciably less than the long-term average, wetlands that depend on snowmelt as an important water source may not flood, pond, or develop shallow water tables and may not exhibit other wetland hydrology indicators. Under these conditions, a site that contains hydric soils and hydrophytic vegetation and no evidence of hydrologic manipulation should be considered to be a wetland. If necessary, revisit the site following a winter with normal snowpack conditions and check again for hydrology indicators.

c. *Periods with below-normal rainfall*. Determine whether the amount of rainfall that occurred in the 2-3 months preceding the site visit was normal, above normal, or below normal based on the normal range reported in WETS tables. In areas where the snowpack does not persist over winter, or for sampling dates later in the growing season, WETS tables provided by the NRCS National Water and Climate Center (http://www.wcc.nrcs.usda.gov/climate/wetlands.html) can be used to determine whether rainfall in a given month was normal, above normal, or below normal based on long-term weather records. To determine whether precipitation was normal prior to the site visit, actual rainfall in the current month and previous 2-3 months should be compared with the normal ranges for each month given in the WETS table (USDA Natural Resources Conservation Service 1997, Sprecher and Warne 2000). The lower and upper limits of the normal range are indicated by the columns labeled "30 percent chance will have less than" and "30 percent chance will have more than." In Alaska, however, weather stations are widely scattered and data may not be available in some areas.

If precipitation is below normal, wetlands may not flood, pond, or develop shallow water tables and may not exhibit other indicators of wetland hydrology. Under these conditions, a site that contains hydric soils and hydrophytic vegetation and no evidence of hydrologic manipulation should be considered to be a wetland. If necessary, revisit the site during a period of normal rainfall and check again for hydrology indicators.

d. *Reference sites*. If indicators of hydric soil and hydrophytic vegetation are present on a site that lacks wetland hydrology indicators, the site may be considered to be a wetland if the landscape setting, topography, soils, and vegetation are

substantially the same as those on nearby wetland reference areas. Wetland reference areas should have documented hydrology established through long-term monitoring or by repeated application of the procedure described in item *2a* of the procedure described earlier in this chapter for "Wetlands that Lack Indicators of Hydrophytic Vegetation." Reference sites should be minimally disturbed and provide long-term access. Soils, vegetation, and hydrologic conditions should be thoroughly documented and the data kept on file in the District or field office.

e. *Long-term hydrologic monitoring.* On sites where the hydrology has been manipulated by man (e.g., ditched or leveed) or where natural events (e.g., change in river course, tectonic activity) have altered conditions such that hydrology indicators may be missing or misleading, direct monitoring of surface and groundwater may be needed to verify the presence or absence of wetland hydrology. The U. S. Army Corps of Engineers (2005) provides minimum standards for the design, construction, and installation of water-table monitoring wells, and for the collection and interpretation of groundwater monitoring data, in cases where direct hydrologic measurements are needed to determine whether wetlands are present on highly disturbed or problematic sites. This standard calls for ≥14 consecutive days of flooding, ponding, or water tables ≤12 in. below the soil surface during the growing season at a minimum frequency of 5 years in 10 (≥50 percent probability). Any area that meets this hydrologic standard and contains hydric soils and hydrophytic vegetation is a wetland.

Wetland/Non-Wetland Mosaics

Description of the problem

In this supplement, "mosaic" refers to a landscape where wetland and non-wetland components are too closely associated to be easily delineated or mapped separately. These areas often have complex microtopography, with repeated small changes in elevation occurring over short distances. The horizontal distance from trough to ridge may be 1 ft (30 cm) or less in some areas, such as those with plants growing in tussocks, to 10 ft (3 m) or more in broadly hummocky areas. Ridges and hummocks are often non-wetland but are interspersed throughout a wetland matrix having clearly hydrophytic vegetation, hydric soils, and wetland hydrology.

Examples of wetland/non-wetland mosaics include many strangmoor/patterned bog systems with flarks (depressions, flooded in spring) and strangs (linear, knee-high ridges, usually oriented at right angles to the

original flow of water over the area), frost circles, patterned ground, and other types of periglacial microtopography. Wetland/non-wetland mosaics also occur in areas of discontinuous permafrost (e.g., north-facing slopes, and burned areas in permafrost-affected regions) and on discharge slopes in southcentral Alaska. In the Anchorage area, wetlands adjacent to streams often contain hummocks associated with the root crowns of trees, and black spruce bogs may contain many knee-high hummocks, usually less than 40 in. (1 m) across the tops.

Wetland components of a mosaic are often not difficult to identify. The problem for the wetland delineator is that microtopographic features are too small and intermingled, and there are too many such features per acre, to delineate and map them accurately. Instead, the following sampling approach is designed to estimate the percentage of wetland in the mosaic. From this, the number of acres of wetland on the site can be calculated, if needed.

Procedure

First, identify and flag all contiguous areas of either wetland or non-wetland on the site that are large enough to be delineated and mapped separately. The remaining area should be mapped as "wetland/non-wetland mosaic" and the approximate percentage of wetland within the area determined by the following procedure.

1. Establish one or more continuous line transects across the mosaic area, as needed. Measure the total length of each transect. A convenient method is to stretch a measuring tape along the transect and leave it in place while sampling. If the site is shaped appropriately and multiple transects are used, they should be arranged in parallel with each transect starting from a random point along one edge of the site. However, other arrangements of transects may be needed for oddly shaped sites.

2. Use separate data forms for the swale or trough and for the ridges or hummocks. Sampling of vegetation, soil, and hydrology should follow the general procedures described in the Corps Manual and this supplement. Plot sizes and shapes for vegetation sampling must be adjusted to fit the microtopographic features on the site. Plots intended to sample the troughs should not overlap adjacent hummocks, and vice versa. Only one or two data forms are required for each microtopographic position, and do not need to be repeated for similar features or plant communities.

3. Identify every wetland boundary in every trough or swale encountered along each transect. Each boundary location may be marked with a pin flag or simply recorded as a distance along the stretched tape.

4. Determine the total distance along each transect that is occupied by wetland and non-wetland until the entire length of the line has been accounted for. Sum these distances across transects, if needed.

Determine the percentage of wetland in the wetland/non-wetland mosaic using the following formula.

$$\%\ wetland = \frac{Total\ wetland\ distance\ along\ all\ transects}{Total\ length\ of\ all\ transects} \times 100$$

An alternative approach involves point-intercept sampling at fixed intervals along transects across the area designated as wetland/non-wetland mosaic. This method avoids the need to identify wetland boundaries in each swale, and can be carried out by pacing rather than stretching a measuring tape across the site. The investigator uses a compass or other means to follow the selected transect line. At a fixed number of paces (e.g., every two steps) the wetland status of that point is determined by observing indicators of hydrophytic vegetation, hydric soil, and wetland hydrology. Again, a completed data form is not required at every point but at least one representative swale and hummock should be documented with completed forms. After all transects have been sampled, the result is a number of wetland sampling points and a number of non-wetland points. Estimate the percentage of wetland in the wetland/non-wetland mosaic using the following formula:

$$\%\ wetland = \frac{Number\ of\ wetland\ points\ along\ all\ transects}{Total\ number\ of\ points\ sampled\ along\ all\ transects} \times 100$$

References

Bailey, R. G. (1995). "Description of the ecoregions of the United States, second edition," Miscellaneous Publication 1391 (revised), U. S. Department of Agriculture, Forest Service, Washington, DC.

Bailey, R. G. (1998). *Ecoregions: The ecosystem geography of the oceans and continents*, Springer-Verlag, New York.

Environmental Laboratory. (1987). "Corps of Engineers Wetlands Delineation Manual," Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. (http://www.wes.army.mil/el/wetlands/pdfs/wlman87.pdf)

Gretag/Macbeth. (2000). *Munsell® color*. New Windsor, NY.

Hall, J. V., W. E. Frayer, and B. O. Wilen. (1994). "Status of Alaska wetlands," U. S. Fish and Wildlife Service, Anchorage, AK.

Laursen, G. A., R. D. Seppelt, and M. P. Zhurbenko. (2005). "Use of crytogams (Bryophytes, Lichenized Fungi, and Fungi) to further delineate Alaskan obligate wetlands and facultative uplands - Phase One: A pilot study for interior and south central physiographic regions," unpublished contract report No. W913E5-04-C-0002 to the U. S. Army Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH.

Lichvar, R., Laursen, G., Seppelt, R., and Ochs, W. (2006, in prep.). "Selection and testing of reliable cryptogam species for use in a hydrophytic vegetation indicator in Alaska," Technical Note __, U. S. Army Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH.

Markon, C. J. (2001). "Seven-year phenological record of Alaskan ecoregions derived from advanced very high resolution radiometer normalized difference vegetation index data," U. S. Geological Survey Open-File Report 01-11, 58 pp. (http://agdcftp1.wr.usgs.gov/pub/projects/lcc/ak_avhrr/pheno_ofr_final.pdf)

Mueller-Dombois, D. and H. Ellenberg. (1974). *Aims and methods of vegetation ecology*. John Wiley & Sons, NY.

Muller, S. W. (1945). "Permafrost or permanently frozen ground and related engineering problems," U.S. Engineers Office, Strategic Engineering Study Special Report 62, 136 pp.

National Research Council. (1995). *Wetlands: Characteristics and boundaries*. National Academy Press, Washington, DC.

Reed, P. B., Jr. (1988). "National list of plant species that occur in wetlands: 1988 National Summary," Biological Report 88(24), U. S. Fish and Wildlife Service, Washington, DC.

Sprecher, S. W., and Warne, A. G. (2000). "Accessing and using meteorological data to evaluate wetland hydrology," Technical Report, ERDC/EL TR-WRAP-00-1, U.S. Army Engineer Research and Development Center, Vicksburg, MS. (http://el.erdc.usace.army.mil/elpubs/pdf/wrap00-1/wrap00-1.pdf)

Tiner, R. W. (1999). *Wetland indicators: A guide to wetland identification, delineation, classification, and mapping*. Lewis Publishers, Boca Raton, FL.

U. S. Army Corps of Engineers. (2005). "Technical Standard for Water-Table Monitoring of Potential Wetland Sites," *WRAP Technical Notes Collection* (ERDC TN-WRAP-05-2), U. S. Army Engineer Research and Development Center, Vicksburg, MS. (http://el.erdc.usace.army.mil/wrap/pdf/tnwrap05-2.pdf)

USDA Natural Resources Conservation Service. (1997). "Hydrology tools for wetland determination," Chapter 19, *Engineering field handbook*, U. S. Department of Agriculture, NRCS, Fort Worth, TX.

USDA Natural Resources Conservation Service. (1999). *Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys.* Agricultural Handbook 436, Washington, DC.

USDA Natural Resources Conservation Service. (2002). "Field book for describing and sampling soils, Version 2.0," P. J. Schoeneberger, D. A. Wysocki, E. C. Benham, and W. D. Broderson (eds.). National Soil Survey Center, Lincoln, NE.

USDA Natural Resources Conservation Service. (2004). "Land resource regions and major land resource areas of Alaska," Palmer, AK. (ftp://ftp-fc.sc.egov.usda.gov/AK/lrr.pdf)

USDA Natural Resources Conservation Service. (2005a). "Field indicators of hydric soils in Alaska: A user guide." Palmer, AK. (ftp://ftp-fc.sc.egov.usda.gov/AK/AKFieldIndicators.pdf).

USDA Natural Resources Conservation Service. (2005b). "National Soil Survey Handbook, Title 430-VI." [Online] (http://soils.usda.gov/technical/handbook/).

USDA Natural Resources Conservation Service. (In press). "Field indicators of hydric soils in the United States, Version 6.0." Hurt, G. W. (ed.). USDA, NRCS in cooperation with the National Technical Committee for Hydric Soils. (http://soils.usda.gov/use/hydric/)

USDA Soil Conservation Service. (1994). "Changes in hydric soils of the United States," Federal Register 59(133): 35680-35681, July 13, 1994.

Vepraskas, M. J. (1992). "Redoximorphic features for identifying aquic conditions," Technical Bulletin 301. North Carolina Agricultural Research Service, North Carolina State Univ., Raleigh, NC.

Viereck, L. A., Van Cleve, K., and Dyrness, C. T.. (1986). "Forest ecosystem distribution in the taiga environment." *Forest ecosystems in the Alaska Taiga: A synthesis of structure and function*. Chapter 3 in K. Van Cleve, F. S. Chapin, III, P. W. Flanagan, L. A. Viereck, and C. T. Dyrness, eds. Springer Verlag, New York, 22-43.

Wakeley, J. S., and Lichvar, R. W. (1997). "Disagreement between plot-based prevalence indices and dominance ratios in evaluations of wetland vegetation," *Wetlands* 17: 301-309.

Wentworth, T. R., Johnson, G. P., and Kologiski, R. L.. (1988). "Designation of wetlands by weighted averages of vegetation data: a preliminary evaluation," *Water Resources Bulletin* 24: 389-396.

Williams, P. J., and M. W. Smith. (1989). *The frozen earth: Fundamentals of geocryology*. Cambridge University Press.

Appendix A
Glossary

This glossary is intended to supplement those given in the Corps Manual and other available sources. See the following publications for terms not listed here:[1]

- Corps Manual (Environmental Laboratory 1987) (http://www.wes.army.mil/el/wetlands/pdfs/wlman87.pdf).
- Field Indicators of Hydric Soils in the United States (USDA Natural Resources Conservation Service, in press) (http://soils.usda.gov/use/hydric/).
- National Soil Survey Handbook, Part 629 (USDA Natural Resources Conservation Service 2005b) (http://soils.usda.gov/technical/handbook/contents/part629glossary1.html#a).

Contrast. The color difference between a redox concentration and the dominant matrix color. Differences are classified as faint, distinct, or prominent and are defined in the glossary of USDA Natural Resources Conservation Service (in press) and illustrated in Table A1.

Cryoturbation. The churning and mixing of soil horizons by frost processes (Williams and Smith 1989).

Depleted matrix. The volume of a soil horizon or subhorizon from which iron has been removed or transformed by processes of reduction and translocation to create colors of low chroma and high value. A, E, and calcic horizons may have low chromas and high values and may therefore be mistaken for a depleted matrix. However, these horizons are excluded from the concept of depleted matrix unless common or many, distinct or prominent redox concentrations as soft masses or pore linings are present. In some places the depleted matrix may change color upon exposure to air (reduced matrix); this phenomenon is included in the concept of depleted matrix. The following combinations of value and chroma identify a depleted matrix:

- Matrix value 5 or more and chroma 1 with or without redox concentrations as soft masses and/or pore linings.

[1] References cited in this appendix can be found in the list of references at the end of the main text.

- Matrix value 6 or more and chroma 2 or 1 with or without redox concentrations as soft masses and/or pore linings.
- Matrix value 4 or 5 and chroma 2 and has 2 percent or more distinct or prominent redox concentrations as soft masses and/or pore linings.
- Matrix value 4 and chroma 1 and has 2 percent or more distinct or prominent redox concentrations as soft masses and/or pore linings (USDA Natural Resources Conservation Service, in press).

Common (2 to less than 20 percent) to many (20 percent or more) redox concentrations (USDA Natural Resources Conservation Service 2002) are required in soils with matrix colors of 4/1, 4/2, and 5/2 (Figure A1). Redox concentrations include iron and manganese masses and pore linings (Vepraskas 1992). See "Contrast" in this glossary for the definitions of "distinct" and "prominent."

Table A1
Tabular Key for Contrast Determinations Using Munsell Notation

Hues are the same ($\Delta h = 0$)			***Hues differ by 2 ($\Delta h = 2$)***		
Δ Value	**Δ Chroma**	**Contrast**	**Δ Value**	**Δ Chroma**	**Contrast**
0	≤1	Faint	0	0	Faint
0	2	Distinct	0	1	Distinct
0	3	Distinct	0	≥2	Prominent
0	≥4	Prominent	1	≤1	Distinct
1	≤1	Faint	1	≥2	Prominent
1	2	Distinct	≥2	---	Prominent
1	3	Distinct			
1	≥4	Prominent			
≤2	≤1	Faint			
≤2	2	Distinct			
≤2	3	Distinct			
≤2	≥4	Prominent			
3	≤1	Distinct			
3	2	Distinct			
3	3	Distinct			
3	≥4	Prominent			
≥4	---	Prominent			

Hues differ by 1 ($\Delta h = 1$)			***Hues differ by 3 or more ($\Delta h \geq 3$)***		
Δ Value	**Δ Chroma**	**Contrast**	**Δ Value**	**Δ Chroma**	**Contrast**
0	≤1	Faint	Color contrast is prominent, except for low chroma and value.		Prominent
0	2	Distinct			
0	≥3	Prominent			
1	≤1	Faint			
1	2	Distinct			
1	≥3	Prominent			
2	≤1	Distinct			
2	2	Distinct			
2	≥3	Prominent			
≥3	---	Prominent			

Note: If both colors have values of ≤3 and chromas of ≤2, the color contrast is *Faint* (regardless of the difference in hue).
Adapted from USDA Natural Resources Conservation Service (2002)

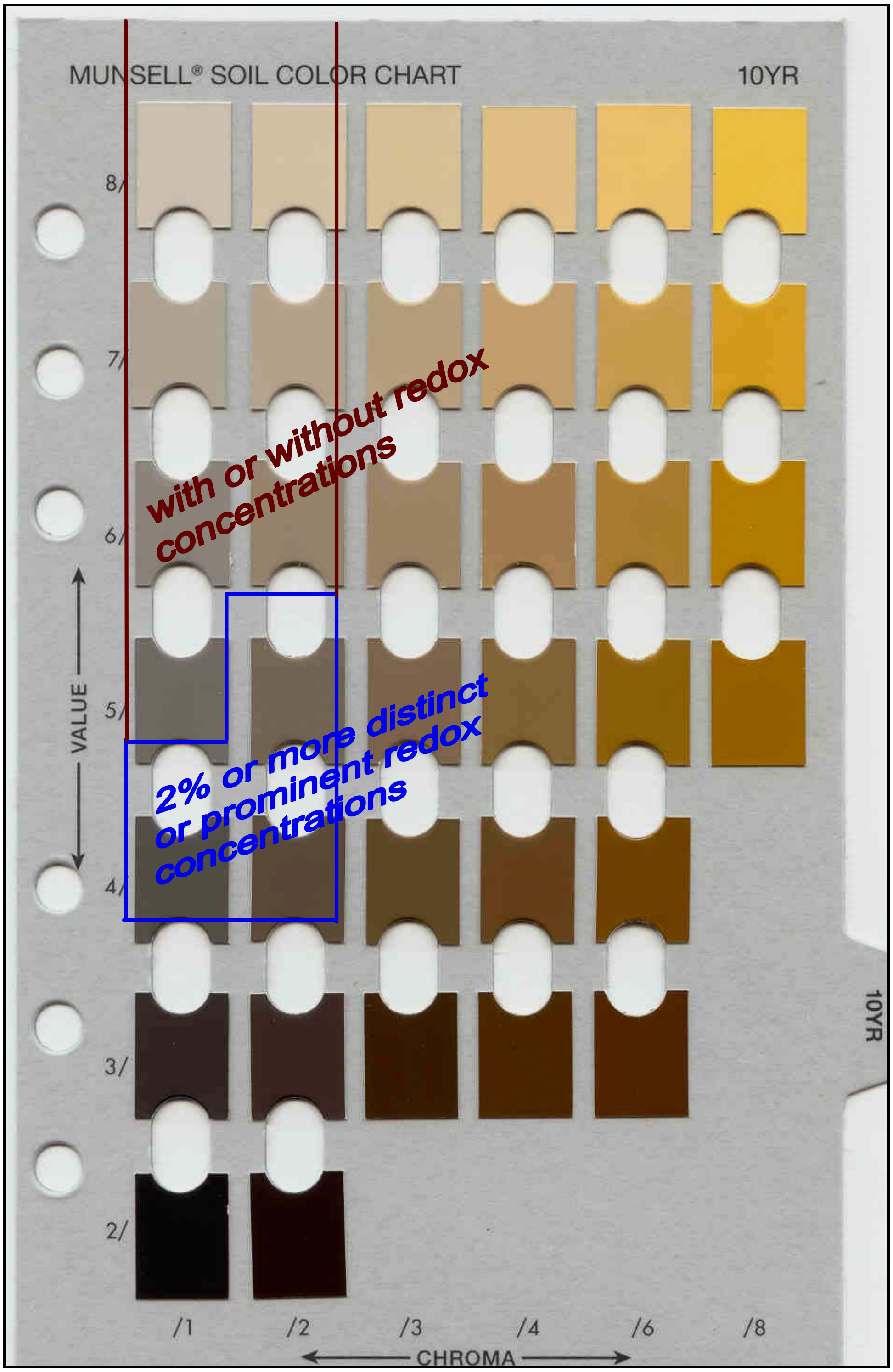

Figure A1. Values and chromas that require 2 percent or more redox concentrations and those that do not, for hue 10YR, to meet the definition of a depleted matrix.

Distinct. See Contrast.

Folistels. Histels that are saturated with water for less than 30 cumulative days during normal years (and are not artificially drained). See *Soil Taxonomy* (USDA Natural Resources Conservation Service 1999) for a complete definition.

Folistic epipedon. Generally defined as an organic layer that is saturated for less than 30 days cumulative and is 6 in. (15 cm) or more thick. See *Soil Taxonomy* (USDA Natural Resources Conservation Service 1999) for a complete definition.

Gleyed matrix. A gleyed matrix has one of the following combinations of hue, value, and chroma and the soil is not glauconitic (Figure A2):

- 10Y, 5GY, 10GY, 10G, 5BG, 10BG, 5B, 10B, or 5PB with value 4 or more and chroma 1.
- 5G with value 4 or more and chroma 1 or 2.
- N with value 4 or more (USDA Natural Resources Conservation Service, in press).

Figure A2. For hydric soil determinations, a gleyed matrix has the hues and chroma identified in this illustration with a value of 4 or more

Growing Season. In Alaska, growing season dates may be determined by evaluating vegetation response at the site location, based on remote sensing or onsite observations (see Chapter 4). Growing season determinations for wetland delineation purposes are subject to Corps of Engineers District approval.

Histels. Organic soils that contain permafrost. See *Soil Taxonomy* (USDA Natural Resources Conservation Service 1999) for a complete definition.

Permafrost. A thickness of soil or other superficial deposits, or even bedrock, which has been colder than 0 °C for two or more years (Muller 1945).

Prominent. See Contrast.

Seasonal Frost. Any material, including soil, which has a temperature of 0 °C or below for a period of less than one year.

Tree throw. The churning and mixing of soil horizons caused by the uplifted roots of wind-felled trees.

Appendix B
Wetland Indicator Statuses of Plants Frequently Encountered During Wetland Determinations in Alaska

This appendix presents lists of plants that are often encountered during wetland determinations in Alaska. These lists are not intended to be exhaustive or complete, but may be useful to wetland delineation practitioners with average botanical skills. The wetland indicator status shown in these lists is the same as that assigned by Reed (1988).[1] Be sure to use the most recent Corps-approved version of the plant list.

For convenience, a separate list of common plants is provided for each subregion of the State (no list has been developed for Western Alaska) (Figure B1). Four of these subregions correspond to the following Land Resource Regions (LRR) in Alaska recognized by the USDA Natural Resources Conservation Service (2004): Aleutian Alaska, Interior Alaska, Northern Alaska, and Western Alaska. The fifth LRR (Southern Alaska) has been split into two subregions – Southcentral Alaska and Southeast Alaska – based on differences in vegetation and climate. Lists of common plants in each subregion are presented in Tables B1 through B5.

[1] References cited in this appendix can be found in the list of references at the end of the main text.

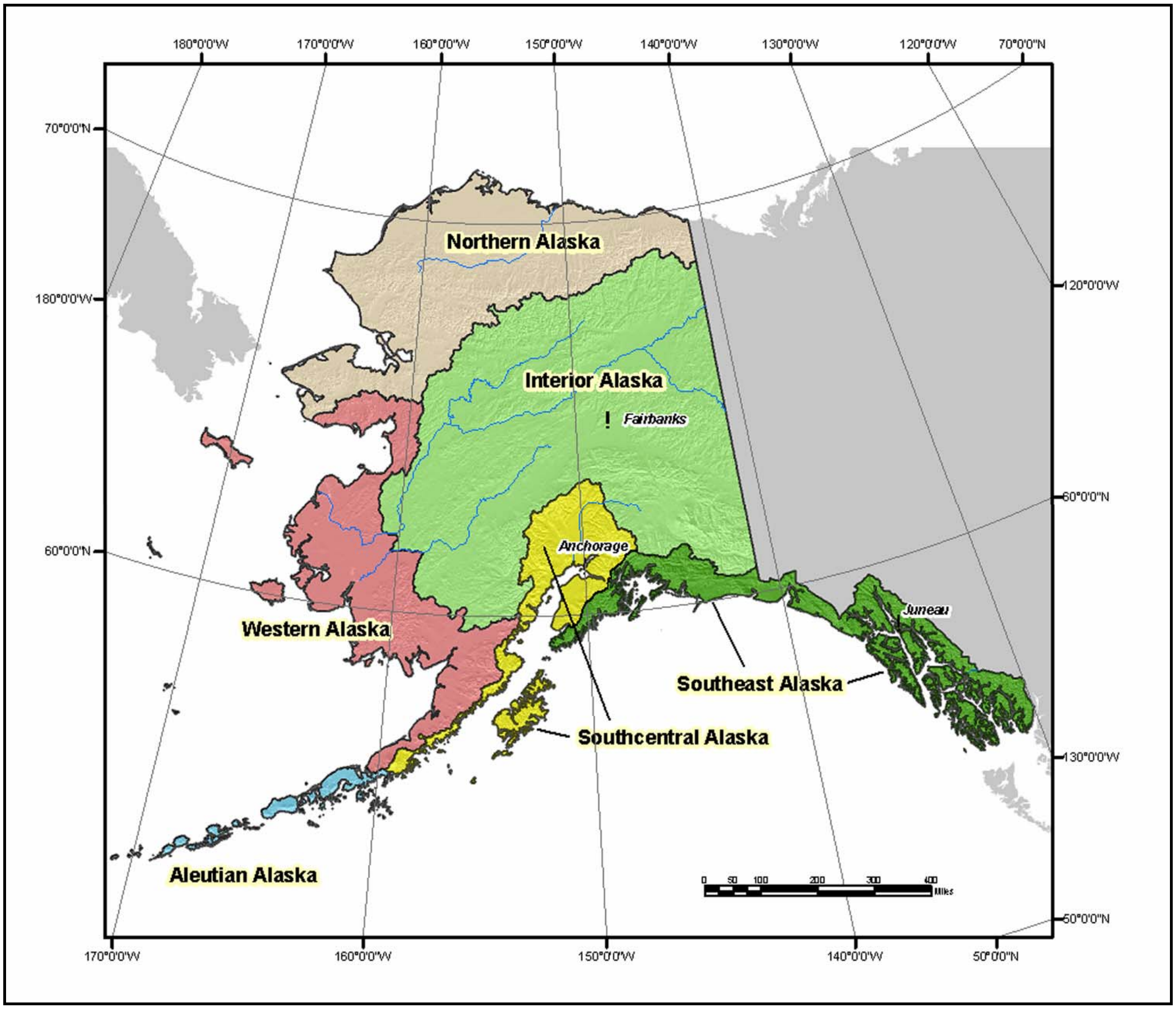

Figure B1. Subregions of Alaska. The entire Aleutian Island chain (not shown) is included in the Aleutian Alaska subregion

Table B1
Common plants in Southeast Alaska

Andromeda polifolia	OBL	*Parnassia palustris*	FACW
Chamaecyparis nootkatensis	FAC	*Picea sitchensis*	FACU
Coptis trifolia	FAC	*Pinguicula vulgaris*	OBL
Drosera rotundifolia	OBL	*Pinus contorta*	FAC
Eleocharis palustris	OBL	*Platanthera stricta*	FACW
Empetrum nigrum	FAC	*Potentilla palustris*	OBL
Erigeron peregrinus	FACW	*Pteridium aquilinum*	FACU
Eriophorum angustifolium	OBL	*Rubus chamaemorus*	FACW
Eriophorum russeolum	FACW	*Sanguisorba canadensis*	FACW
Fauria crista-galli	FACW	*Scirpus cespitosus*	OBL
Fritillaria camschatcensis	FAC	*Swertia perennis*	FAC
Gentiana douglasiana	FACW	*Thuja plicata*	FAC
Hippuris vulgaris	OBL	*Tofieldia glutinosa*	FACW
Iris setosa	FAC	*Trientalis europaea*	FAC
Juniperus communis	UPL	*Tsuga heterophylla*	FAC
Kalmia polifolia	FACW	*Tsuga mertensiana*	FAC
Ledum groenlandicum	FACW	*Vaccinium cespitosum*	FACW
Lycopodium annotinum	FAC	*Vaccinium ovalifolium*	FAC
Lysichiton americanum	OBL	*Vaccinium oxycoccus*	OBL
Menyanthes trifoliata	OBL	*Vaccinium uliginosum*	FAC
Menziesia ferruginea	UPL	*Viola langsdorffii*	FACW
Nuphar luteum	OBL	*Viola palustris*	NI

Table B2
Common plants in Southcentral Alaska

Achillea millefolium	FACU	*Equisetum palustre*	FACW
Aconitum delphinifolium	FAC	*Equisetum pratense*	FACW
Alnus sinuata	FAC	*Equisetum scirpoides*	FACU
Alnus tenuifolia	FAC	*Equisetum sylvaticum*	FACU
Andromeda polifolia	OBL	*Equisetum variegatum*	FACW
Anemone narcissiflora ssp. alaskana	UPL	*Erigeron peregrinus*	FACW
Angelica lucida	FACU	*Eriophorum angustifolium*	OBL
Arctagrostis latifolia	FACW	*Eriophorum brachyantherum*	OBL
Artemisia arctica	UPL	*Eriophorum russeolum*	FACW
Artemisia tilesii	UPL	*Eriophorum scheuchzeri*	OBL
Aster sibiricus	FAC	*Galium boreale*	FACU
Athyrium filix-femina	FAC	*Geocaulon lividum*	FACU
Beckmannia eruciformis	OBL	*Geranium erianthum*	NI
Betula glandulosa	FAC	*Geum macrophyllum*	FACW
Betula nana	FAC	*Goodyera repens*	FAC
Betula paprifera	FACU	*Gymnocarpium dryopteris*	FACU
Calamagrostis canadensis	FAC	*Heracleum lanatum*	FACU
Carex aquatilis	OBL	*Hippuris montana*	OBL
Carex limosa	OBL	*Hippuris vulgaris*	OBL
Carex livida	OBL	*Iris setosa*	FAC
Carex lyngbyei	OBL	*Juncus alpinus*	OBL
Carex mertensii	FACW	*Juncus arcticus*	OBL
Carex micropoda	FACW	*Juncus biglumis*	OBL
Carex podocarpa	FAC	*Juncus castaneus*	FACW
Carex rhynchophysa	OBL	*Juncus filiformis*	FACW
Carex rostrata	OBL	*Juncus mertensianus*	OBL
Harrimanella stelleriana	FACU	*Ledum decumbens*	FACW
Castilleja unalaschcensis	FAC	*Linnaea borealis*	UPL
Chamaedaphne calyculata	FACW	*Listera cordata*	FACU
Cornus canadensis	FACU	*Luetkea pectinata*	UPL
Cornus suecica	FAC	*Lupinus nootkatensis*	FAC
Dasiphora floribunda	UPL	*Luzula parviflora*	FAC
Deschampsia cespitosa	FAC	*Lycopodium annotinum*	FAC
Drosera rotundifolia	OBL	*Lycopodium clavatum*	UPL
Dryas drummondii	FACU	*Maianthemum dilatatum*	NI
Dryopteris dilatata	FACU	*Matteuccia struthiopteris*	FACW
Eleocharis palustris	OBL	*Menyanthes trifoliata*	OBL
Empetrum nigrum	FAC	*Menziesia ferruginea*	UPL
Epilobium angustifolium	FACU	*Mertensia paniculata*	FACU
Epilobium latifolium	FAC	*Moneses uniflora*	NI
Equisetum fluviatile	OBL	*Myrica gale*	OBL

(Continued)

Table B2 (Concluded)

Oplopanax horridus	FACU	*Salix planifolia*	FACW
Parnassia palustris	FACW	*Salix reticulata*	FAC
Picea glauca	FACU	*Salix richardsonii*	FAC
Picea x lutzii	NI	*Salix arbusculoides*	FACW
Picea mariana	FACW	*Salix sitchensis*	FAC
Picea sitchensis	FACU	*Sambucus racemosa*	FACU
Platanthera hyperborea	FACW	*Sanguisorba officinalis*	FAC
Polemonium acutiflorum	FAC	*Sanguisorba canadensis*	FACW
Populus balsamifera	FACU	*Scirpus cespitosus*	OBL
Potentilla anserina	FACW	*Senecio triangularis*	FACW
Potentilla fruticosa	FAC	*Shepherdia canadensis*	NI
Potentilla palustris	OBL	*Sorbus scopulina*	NI
Prunus virginiana	NI	*Spiranthes romanzoffiana*	OBL
Pyrola asarifolia	FAC	*Streptopus amplexifolius*	FAC
Pyrola minor	FAC	*Thalictrum sparsiflorum*	FACU
Ribes glandulosum	FACU	*Thelypteris phegopteris*	UPL
Ribes triste	FAC	*Tofieldia glutinosa*	FACW
Rorippa palustris	FAC	*Triglochin maritimum*	OBL
Rosa acicularis	FACU	*Trientalis europaea*	FAC
Rubus arcticus	FAC	*Urtica dioica ssp. gracilis*	FACU
Rubus chamaemorus	FACW	*Vaccinium oxycoccos*	OBL
Rubus idaeus	FAC	*Vaccinium ovalifolium*	FAC
Rubus pedatus	FAC	*Vaccinium uliginosum*	FAC
Rubus spectabilis	FACU	*Vaccinium vitis-idaea*	FAC
Rumex arcticus	FACW	*Valeriana capitata*	FAC
Salix arbusculoides	FACW	*Viburnum edule*	FACU
Salix arctica	FAC	*Viola epipsila ssp. repens*	UPL
Salix barclayi	FAC	*Viola langsdorffii*	FACW
Salix fuscescens	FACW	*Viola selkirkii*	UPL

Table B3
Common Plants in Interior Alaska

Arctophila fulva	OBL	*Geocaulon lividum*	FACU
Alnus crispa	FAC	*Iris setosa*	FAC
Alnus tenuifolia	FAC	*Juncus alpinus*	OBL
Andromeda polifolia	OBL	*Larix laricina*	FACW
Beckmania eruciformis	OBL	*Ledum decumbens*	FACW
Betula glandulosa	FAC	*Ledum groenlandicum*	FACW
Betula nana	FAC	*Menyanthes trifoliata*	OBL
Betula papyrifera	FACU	*Mertensia paniculata*	FACU
Calamagrostis canadensis	FAC	*Myrica gale*	OBL
Carex aquatilis	OBL	*Nuphar luteum ssp. polysepalum*	UPL
Carex aurea	FACW	*Nymphaea tetragona*	OBL
Carex diandra	OBL	*Parnassia palustris*	FACW
Carex lasiocarpa	OBL	*Picea glauca*	FACU
Carex limosa	OBL	*Picea mariana*	FACW
Carex podocarpa	FAC	*Polemonium acutiflorum*	FAC
Carex rostrata	OBL	*Populus balsamifera*	FACU
Carex vaginata	OBL	*Populus tremula*	FACU
Calla palustris	OBL	*Potamogeton natans*	OBL
Chamaedaphne calyculata	FACW	*Potamogeton richardsonii*	OBL
Cicuta mackenziana	OBL	*Potamogeton vaginatus*	OBL
Cornus canadensis	FACU	*Pyrola asarifolia*	FAC
Drosera anglica	OBL	*Pyrola grandiflora*	FAC
Drosera rotundifolia	OBL	*Rosa acicularis*	FACU
Eleocharis palustris	OBL	*Rubus chamaemorus*	FACW
Empetrum nigrum	FAC	*Rubus idaeus*	FAC
Epilobium angustifolium	FACU	*Salix alaxensis*	FAC
Equisetum arvense	FACU	*Salix arbusculoides*	FACW
Equisetum fluviatile	OBL	*Salix fuscescens*	FACW
Equisetum palustre	FACW	*Salix reticulata*	FAC
Equisetum pratense	FACW	*Salix richardsonii*	FAC
Equisetum scirpoides	FACU	*Typha latifolia*	OBL
Equisetum sylvaticum	FACU	*Vaccinium uliginosum*	FAC
Eriophorum angustifolium	OBL	*Vaccinium vitis-idaea*	FAC
Eriophorum scheuchzeri	OBL	*Viburnum edule*	FACU
Galium boreale	FACU		

Table B4
Common Plants in Northern Alaska

Andromeda polifolia	OBL	*Hippuris vulgaris*	OBL
Arctagrostis latifolia	FACW	*Juncus biglumis*	OBL
Calamagrostis canadensis	FAC	*Ledum groenlandicum*	FACW
Cardamine pratensis	OBL	*Luzula wahlenbergii*	OBL
Carex aquatilis	OBL	*Pedicularis abolabiata*	FACW
Carex podocarpa	FAC	*Pedicularis labradorica*	FACW
Carex rariflora	OBL	*Pedicularis langsdorfii*	FACW
Carex rotundata	OBL	*Potentilla palustris*	OBL
Carex saxatilis	FACW	*Rubus chamaemorus*	FACW
Carex vaginata	OBL	*Salix chamissonis*	NI
Caxex foliolosa	FACW	*Salix fuscescens*	FACW
Dodecatheon frigidum	FACW	*Salix planifolia*	FACW
Equisetum variegatum	FACW	*Saxifraga cernua*	FACW
Eriophorum scheuchzeri	OBL	*Saxifraga rivularis*	OBL
Eriophorum angustifolium ssp. triste	NI	*Sparganium hyperboreum*	OBL
Eriophorum vaginatum	FACW		

Table B5
Common Plants in Aleutian Alaska

Achillea millefolium	FACU	*Eriophorum russeolum*	FACW
Aconitum delphinifolium	FAC	*Festuca altaica*	FAC
Agrostis alaskana	OBL	*Festuca brachyphylla*	UPL
Anaphalis margaritacea	UPL	*Festuca rubra*	FAC
Anemone narcissiflora ssp. alaskana	UPL	*Fragaria chiloensis ssp. pacifica*	UPL
Angelica lucida	FACU	*Fritillaria camschatcensis*	FAC
Antennaria monocephala	UPL	*Galium aparine*	FACU
Arnica chamissonis	FACW	*Galium trifidum*	FACW
Artemisia arctica	UPL	*Geranium pratense*	FAC
Artemisia tilesii	UPL	*Geum calthifolium*	FACW
Athyrium filix-femina	FAC	*Geum macrophyllum*	FACW
Bromus sitchensis var. aleutensis	UPL	*Geum rossii*	FACU
Calamagrostis nutkaensis	FAC	*Heracleum lanatum*	FACU
Calamagrostis purpurascens	UPL	*Hieracium triste*	UPL
Caltha palustris	OBL	*Hierochloe odorata*	FACU
Campanula lasiocarpa	UPL	*Honkenya peploides*	OBL
Cardamine bellidifolia	FAC	*Juncus arcticus*	OBL
Cardamine umbellata	FACW	*Ligusticum scothicum*	FAC
Carex anthoxanthea	FACW	*Listera cordata*	FACU
Carex circinata	UPL	*Lupinus nootkatensis*	FAC
Carex lyngbyei	OBL	*Luzula multiflora*	FACU
Carex macrochaeta	FACW	*Luzula parviflora*	FAC
Carex pluriflora	OBL	*Luzula nivalis*	FAC
Cassiope lycopodioides	UPL	*Lycopodium alpinum*	FACU
Castilleja unalaschcensis	FAC	*Lycopodium annotinum*	FAC
Cerastium beeringianum	FAC	*Mimulus guttatus*	OBL
Claytonia sibirica	FACW	*Pedicularis oederi*	UPL
Conioselinum chinense	FACW	*Pedicularis verticillata*	FAC
Coptis trifolia	FAC	*Petasites frigidus*	FACW
Cornus suecica	FAC	*Phleum alpinum*	FACU
Dactylorhiza aristata	FAC	*Phleum commutatum var. americanum*	FACU
Deschampsia cespitosa ssp. beringensis	UPL	*Platanthera dilatata*	FACW
Deschampsia cespitosa	FAC	*Poa arctica*	FAC
Elymus arenarius ssp. mollis	UPL	*Polemonium acutiflorum*	FAC
Empetrum nigrum	FAC	*Polygonum viviparum*	FAC
Epilobium angustifolium	FACU	*Primula cuneifolia ssp. saxifragifolia*	UPL
Epilobium hornemannii ssp. behringianum	UPL	*Ranunculus occidentalis*	FACW
Equisetum arvense	FACU	*Rhinanthus arcticus*	FAC
Equisetum variegatum	FACW	*Rhododendron camtschaticum*	UPL
Erigeron peregrinus	FACW	*Rubus arcticus*	*FAC*
Eriophorum angustifolium	OBL	*Rubus chamaemorus*	*FACW*

(Continued)

Table B5 (Concluded)

Rumex arcticus	FACW	*Stellaria humifusa*	OBL
Salix arctica	FAC	*Taraxacum trigonolobum*	UPL
Salix reticulata	FAC	*Tofieldia coccinea*	FAC
Salix rotundifolia	NI	*Trientalis europaea*	FAC
Sanguisorba canadensis	UPL	*Trisetum spicatum*	FAC
Sibbaldia procumbens	UPL	*Veronica stelleri*	UPL
Solidago canadensis var. salebrosa	UPL	*Viola langsdorffii*	FACW
Stellaria calycantha	FACW		

Appendix C
Procedure for the Dominance Test for Hydrophytic Vegetation

The following procedure may be used with the approval of the Corps of Engineers Alaska District to identify hydrophytic vegetation in limited situations in Alaska. The procedure involves the selection of dominant species from each stratum of the plant community and determining whether the community is hydrophytic based on the indicator status of dominant species. For most plant communities in Alaska, this procedure is not recommended due in part to difficulties in defining meaningful strata for Alaskan vegetation and problems associated with plant communities (e.g., many muskegs and bogs) in which most species are short and have <20 percent relative cover. In addition, use of the prevalence index as the primary indicator of hydrophytic vegetation may help reduce the occurrence of some problematic wetland situations in Alaska. The preferred indicators of hydrophytic vegetation are described in Chapter 2. However, this alternative indicator may be useful in certain plant communities that have obvious stratification, such as some forested areas in Southeast Alaska and some riparian areas throughout the state. Before using this indicator, consult the Corps of Engineers Alaska District for approval.

Strata

Vegetation strata help facilitate plant sampling and ensure that plants of all sizes are considered in the hydrophytic vegetation determination. The structure of vegetation varies greatly in wetland communities across the state. Throughout much of Alaska, short-stature woody plants are an important part of many communities, such as muskegs, bogs, and tundra wetlands. Important information about the wetland status of the community can be lost when short woody plants are combined into the herb stratum for sampling, as suggested in the Corps Manual. Therefore, the following strata are suggested for use in Alaska. This system places short woody shrubs in the sapling/shrub stratum and limits the herb stratum to only herbaceous vascular plant species. Unless otherwise noted, any stratum with <5 percent total plant cover may be combined

with the next lower stratum for sampling purposes. Sampling of cryptogams is not needed for hydrophytic vegetation determinations involving vascular plants.

1. *Tree stratum* – Consists of woody plants ≥3 in. (7.6 cm) in diameter at breast height (DBH).
2. *Sapling/shrub stratum* – Consists of woody plants <3 in. DBH, regardless of height.
3. *Herb stratum* – Consists of all herbaceous (non-woody) plants, regardless of size.

Dominance test

Description: More than 50 percent of the dominant plant species across all strata are rated OBL, FACW, or FAC.

User Notes: Use the 50/20 rule described below to select dominant species from each stratum of the community. Combine dominant species across strata and apply the dominance test to the combined list. Once a species is selected as a dominant, its cover value is not used in the dominance test; each dominant species is treated equally. Thus, a plant community with seven dominant species across all strata would need at least four dominant species that are OBL, FACW, or FAC to be considered hydrophytic by this indicator. Species that are dominant in two or more strata should be counted two or more times in the dominance test.

Procedure for Selecting Dominant Species by the 50/20 Rule: Dominant plant species are the most abundant species in the community; they contribute more to the character of the community than do the other non-dominant species present. The "50/20 rule" is a repeatable and objective procedure for selecting dominant plant species and is recommended when data are available for all species in the community. The rule can also be used to guide visual sampling of plant communities in rapid wetland determinations.

Dominant species are chosen independently from each stratum of the community. In general, dominants are the most abundant species that individually or collectively account for more than 50 percent of the total coverage of vegetation in the stratum, plus any other species that, by itself, accounts for at least 20 percent of the total. For the purposes of this regional supplement, absolute percent cover is the recommended abundance measure for plants in all vegetation strata. See Table C1 for an example application of the 50/20 rule in evaluating a plant community. Steps in selecting dominant species by the 50/20 rule are as follows:

1. Estimate the absolute percent cover of each species in the first stratum.

2. Rank all species in the stratum from most to least abundant.

3. Calculate the total coverage of all species in the stratum (i.e., sum their individual percent cover values). Absolute cover estimates do not necessarily sum to 100 percent.

4. Select plant species from the ranked list, in decreasing order of coverage, until the cumulative coverage of selected species *exceeds* 50 percent of the total coverage for the stratum. If two or more species are equal in coverage (i.e., they are tied in rank), they should all be selected. The selected plant species are all considered to be dominants. All dominants must be identified to species.

5. In addition, select any other species that, by itself, is at least 20 percent of the total percent cover in the stratum. Any such species is also considered to be a dominant and must be accurately identified.

6. Repeat steps 1-5 for any other stratum present. Combine the lists of dominant species across all strata. Note that a species may be dominant in more than one stratum (e.g., a woody species may be dominant in both the tree and sapling/shrub strata).

Table C1
Example of the Selection of Dominant Species by the 50/20 Rule and Determination of Hydrophytic Vegetation by the Dominance Test

Stratum	Species Name	Wetland Indicator Status	Percent Cover	Dominant?
Herb	*Matteuccia struthiopteris*	FACW	40	Yes
	Impatiens noli-tangere	FACW	20	Yes
	Equisetum arvense	FACU	10	No
	Ribes hudsonianum	FAC	10	No
	Thalictrum sparsiflorum	FACU	10	No
	Calamagrostis canadensis	FAC	5	No
	Dryopteris dilatata	FACU	5	No
	Oplopanax horridus	FACU	5	No
	Streptopus amplexifolius	FAC	5	No
		Total cover	110	
		50/20 Thresholds: 50% of total cover = 55% 20% of total cover = 22%		
Sapling/shrub	*Salix alaxensis*	FAC	80	Yes
	Populus balsamifera	FACU	10	No
	Alnus sinuata	FAC	10	No
		Total cover	100	
		50/20 Thresholds: 50% of total cover = 50% 20% of total cover = 20%		
Tree	*Populus balsamifera*	FACU	10	Yes
Hydrophytic Vegetation Determination	Total number of dominant species across all strata = 4. Percent of dominant species that are OBL, FACW, or FAC = 3/4 = 75%. Therefore, this community is hydrophytic by the Dominance Test.			

Appendix D
Data Form

WETLAND DETERMINATION DATA FORM – Alaska Region

Project/Site: ______________________ Borough/City: ______________________ Sampling Date: __________

Applicant/Owner: ______________________ Sampling Point: __________

Investigator(s): ______________________ Landform (hillside, terrace, hummocks, etc.): ______________________

Local relief (concave, convex, none): ______________________ Slope (%): __________

Subregion: ______________________ Lat: ______________________ Long: ______________________ Datum: __________

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ______ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ______	No ______	**Is the Sampled Area within a Wetland? Yes ______ No ______**
Hydric Soil Present?	Yes ______	No ______	
Wetland Hydrology Present?	Yes ______	No ______	

Remarks:

VEGETATION

Species (Use scientific names. List all species in plot.)	Absolute % Cover	Indicator Status
1. ______	______	______
2. ______	______	______
3. ______	______	______
4. ______	______	______
5. ______	______	______
6. ______	______	______
7. ______	______	______
8. ______	______	______
9. ______	______	______
10. ______	______	______
11. ______	______	______
12. ______	______	______
13. ______	______	______
14. ______	______	______
15. ______	______	______
16. ______	______	______
17. ______	______	______
18. ______	______	______
19. ______	______	______
20. ______	______	______
Total Cover:	______	

Plot size ______________________ % Bare Ground __________

% Cover of Wetland Bryophytes __________ Total Cover of Bryophytes __________

Prevalence Index:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = __________

Other Indicators of Hydrophytic Vegetation:
(Record supporting data in Remarks or on a separate sheet.)

___ Wetland Cryptogams (record species and cover at left)

___ Morphological Adaptations

___ Problematic Hydrophytic Vegetation (Explain)

Hydrophytic Vegetation Present? Yes ________ No ________

Remarks:

SOIL

Sampling Point: ___________

Profile Description: (Describe to the depth needed to document the indicator.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Redox Features Type[1]	Redox Features Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix. [2]Location: PL=Pore Lining, RC=Root Channel, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol or Histel (A1)
- ___ Histic Epipedon (A2)
- ___ Hydrogen Sulfide (A4)
- ___ Thick Dark Surface (A12)
- ___ Alaska Gleyed (A13)
- ___ Alaska Redox (A14)
- ___ Alaska Gleyed Pores (A15)

Indicators for Problematic Hydric Soils[3]:

- ___ Alaska Color Change (TA4)[4]
- ___ Alaska Alpine Swales (TA5)
- ___ Alaska Redox With 2.5Y Hue
- ___ Alaska Gleyed Without Hue 5Y or Redder Underlying Layer
- ___ Other (Explain in Remarks)

[3]One indicator of hydrophytic vegetation, one primary indicator of wetland hydrology, and an appropriate landscape position must be present.
[4]Give details of color change in Remarks.

Restrictive Layer (if present):

Type: ______________________________

Depth (inches): ______________________

Hydric Soil Present? Yes _____ No _____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (any one indicator is sufficient)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Mat or Crust of Algae or Marl (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Dry-Season Water Table (C2)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-stained Leaves (B9)
- ___ Drainage Patterns (B10)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Salt Deposits (C5)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No _____ Depth (inches): ____________

Water Table Present? Yes _____ No _____ Depth (inches): ____________

Saturation Present? (includes capillary fringe) Yes _____ No _____ Depth (inches): ____________

Wetland Hydrology Present? Yes _____ No _____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
February 2006

2. REPORT TYPE
Final report

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE

Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

U.S. Army Corps of Engineers

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

8. PERFORMING ORGANIZATION REPORT NUMBER

ERDC/EL TR-06-3

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Corps of Engineers
Washington, DC 20314-1000

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

This document is one of a series of Regional Supplements to the Corps of Engineers Wetlands Delineation Manual, which provides technical guidance and procedures for identifying and delineating wetlands that may be subject to regulatory jurisdiction under Section 404 of the Clean Water Act. The development of Regional Supplements is part of a nationwide effort to address regional wetland characteristics and improve the accuracy and efficiency of wetland-delineation procedures. This supplement is applicable to the Alaska Region, which is defined herein as the entire state of Alaska.

15. SUBJECT TERMS

Delineation	Plant communities	Vegetation
Hydrology	Soil	Wetlands

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER *(include area code)*
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED		106	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. 239.18